DENVER WILDLIFE RESEARCH CENTER

INTERNATIONAL PROGRAMS RESEARCH SECTION

VERTEBRATE PEST MANAGEMENT IN AGRICULTURE

OUTREACH PROGRAM—FY 1992

PROBLEM SOLVING RESEARCH TECHNOLOGY TRANSFER EXTENSION
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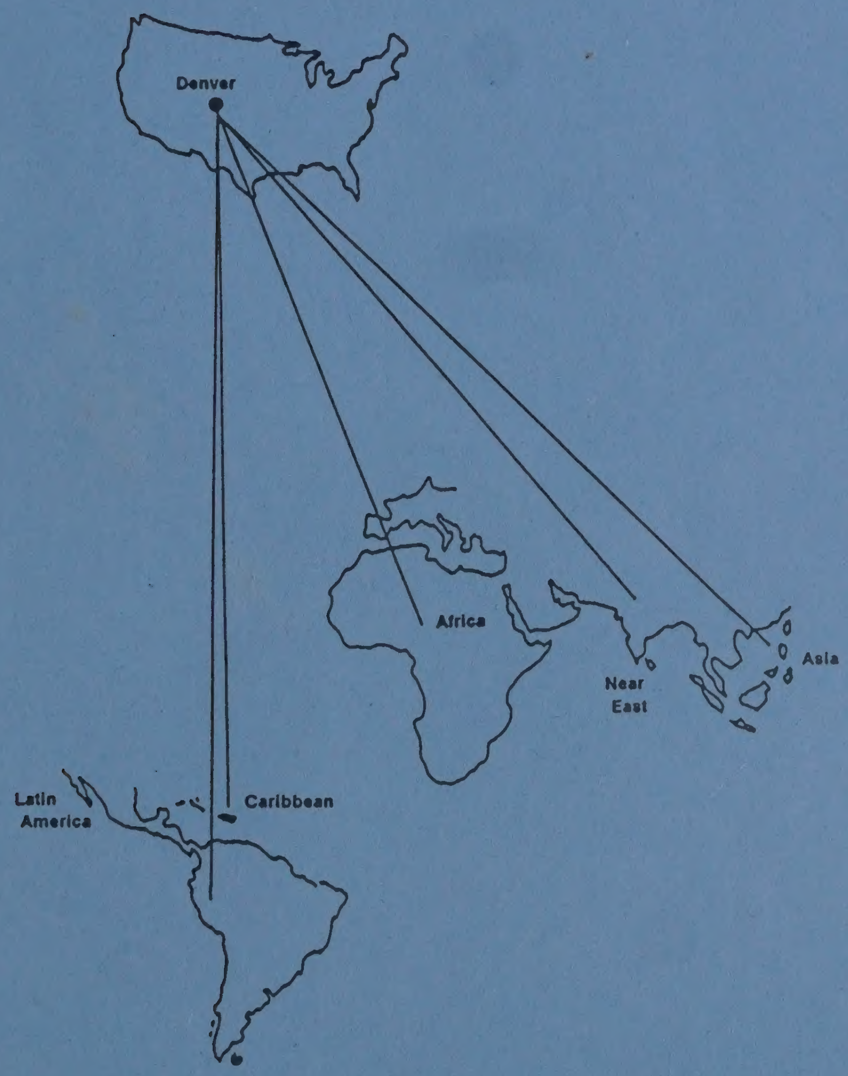

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH
INSPECTION SERVICE
ANIMAL DAMAGE CONTROL

U.S. AGENCY FOR INTERNATIONAL
DEVELOPMENT

United States Department of Agriculture

Animal and Plant Health Inspection Service

Animal Damage Control

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OUTREACH ACTIVITIES

International Programs Research Section

November 1992

This document is a compilation of trip reports resulting from international requests for Denver Wildlife Research Center (DWRC) technical assistance in vertebrate pest management and environmental pesticide use. During Fiscal Year 1992, DWRC staff facilitated 34 consultancies by 23 different individuals to the following countries in Africa, Asia, Europe, and South America to assess vertebrate pest problems and environmental issues; to conduct, review, evaluate, and coordinate present and future activities; to participate in training workshops; and to present technical seminars.

Argentina	Hong Kong	Nicaragua
Bangladesh	India	Niger
Burkina Faso	Indonesia	Pakistan
Chad	Japan	Philippines
Côte d'Ivoire	Malaysia	Senegal
Egypt	Mali	Thailand
Guam	Morocco	Uruguay

These consultancies were at the request of the Africa Emergency Locust and Grasshopper Assistance Program (AELGA), Food and Agriculture Organization (FAO) of the United Nations, U.S. Agency for International Development (USAID), and foreign governments. The consultancies had a diverse range of topics including problem assessment and project planning of pest birds; training and research on the impact of locust sprays on the environment and nontarget wildlife; rodent control research; project research and institutionalization; and preliminary research activities to develop methods for management of the brown tree snake.

Richard L. Bruggers

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Chief, International Programs Research Section

FY-92 TRIP REPORTS

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FY-92 Trip Reports (Continued)

Bruggers, R. L. 1992. Bangladesh vertebrate pest research and project administration. Trip Report--Bangladesh. 7 pp.

Saltz, D. 1992. A review of study design, statistical analysis, and computer applications at the Vertebrate Pest Section of Bangladesh Agricultural Research Institute. Trip Report--Bangladesh. 16 pp. and 2 appendices.

Harris, C. E. 1992. Review of 1991-1992 predator research. Trip Report--Bangladesh. 9 pp.

Brooks, J. E. 1992. Pakistan, Bangladesh, and India: program review, rat control campaign evaluation, and cooperative research. Trip Report--Pakistan, Bangladesh, and India. 19 pp. and 2 appendices.

Jackson, J. J. 1992. Improving extension efforts in rodent control in Bangladesh. Trip Report--Bangladesh. 13 pp. and 5 appendices.

Brooks, J. E. 1992. Chad Rodent Project: administration, research, and training. Trip Report--Chad. 11 pp. and 4 attachments.

Dolbeer, R. A. 1992. Rodent control training and rodenticide field trials in Chad. Trip Report--Chad. 19 pp. and 1 appendix.

Savarie, P. J. 1992. Brown Tree Snake activities in Guam and snake meeting in Okinawa, Japan. Trip Report--Guam and Japan. 6 pp. and 1 appendix.

Fiedler, L. A., and W. B. Jackson. 1992. Vertebrate pest management in tropical Asia. Trip Report--Philippines, Indonesia, Thailand, Malaysia, Hong Kong, and India. 36 pp. and 3 appendices.

Note: Trip reports are on file at the International Programs Research Section, DWRC.

METHYL BROMIDE FUMIGATION OF BROWN TREE SNAKE*

on GUAM

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Unpublished Progress Report

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ABSTRACT

The effectiveness of methyl bromide as a fumigant for brown tree snakes (*Boiga irregularis*) was evaluated on Guam during September and October 1991. A simulated nonfood cargo situation with snakes was established and 18 snakes were randomly positioned in a tarpaulin-covered cargo container for each fumigation test. Methyl bromide was applied at rates of 1.5 lbs/2 hrs, 1.5 lbs/1 hr, 0.75 lbs/2 hrs, and 0.75 lbs/1 hr, all per 1,000 ft^3. All snakes died within about 18 hrs at the 1.5 lbs/2 hrs rate and within 2.5 days at 0.75 lbs/2 hrs. Thirty-two of 36 snakes were dead after 3 days at the 1.5 lbs/1 hr rate, but all were dead by 10.5 days. One snake died after 4.5 days at the 0.75 lbs/1 hr rate; this was still the only snake dead when the trial ended 10 days posttreatment. Methyl bromide is registered with the U.S. Environmental Protection Agency (EPA) for many fumigation purposes and is currently used on Guam in many noncargo situations. Modification of certain registration labels would make it available as a tool to help reduce snake dispersal to other Pacific islands.

INTRODUCTION

The brown tree snake (Family: Colubridae) is considered to be the primary factor responsible for the extirpation of much of the native bird fauna on Guam (Savidge 1987, Fritts 1988). Because Guam is a focal point of air and ship cargo traffic in the Pacific, there is the threat that brown tree snakes could be inadvertently introduced to snake-free islands in the Pacific through shipments of cargo. Brown tree snakes have been discovered in other Pacific regions (Honolulu, Hawaii; Wake Island; Kwajalein Island; and Saipan), but apparently Guam has the only known reproductive population outside of its native range (Fritts 1987).

Fumigation of cargo that has a high probability of harboring snakes is one method that could be used to prevent dispersal of snakes. The present study was designed to test the hypothesis that methyl bromide will kill brown tree snakes when used as a fumigant. Methyl bromide was selected because it has a good safety record, is used world-wide as a space fumigant for numerous insect pests, and is registered by EPA. It is a gaseous fumigant used for soil, commodity, horticultural, structural (buildings), and machinery fumigation purposes. It is registered with EPA at a rate of 4-5 oz/1,000 ft^3 for 12-18 hrs to fumigate rats and mice. EPA-registered application rates of 1-5 lbs/1,000 ft^3 for 2-24 hrs are common for a variety of pests, such as beetles, weevils, moths, and maggots (Great Lakes Chemical Corporation 1987). It has been reported in the literature that methyl bromide kills snakes, but the species were not identified and no data were presented (Brock and Howard 1962). Computerized searches of literature databases were conducted, but no references with data on the toxicity of methyl bromide to brown tree snakes were found.

We conducted this study on Guam during the period from September 15 to October 9, 1991. In initiating this work, we did not envision that all cargo leaving Guam could be fumigated for snakes. Such a practice would clearly be logistically and financially impossible. Likewise, methyl bromide is not be an acceptable fumigant for all types of cargo. However, for snake management purposes it was desirable to establish whether fumigated cargo would be free of live snakes and to assess the possibility that fumigation could be an option for use in an Integrated Pest Management (IPM) program currently being planned. Some procedures also need to be implemented to identify the potential risk of transporting snakes in cargo from Guam. A similar risk assessment could be conducted at other island destinations to determine which kinds of incoming cargo from Guam could be fumigated. However, if an EPA registration process for methyl bromide were completed, a new tool would be available to help deter the spread of brown tree snakes.

FUMIGATION TRIAL DESIGN

Methyl bromide fumigation tests were conducted in cargo containers under a tarpaulin using standard PPQ procedures for tarpaulin fumigation. Mr. W. Scott Wood, a USDA-certified regulatory pesticide applicator, participated in all phases of fumigation.

One hundred and eight snakes were live-captured in Guam from chain-link fences, the ground, and tree branches. Snakes were caged in plastic storage boxes (approximately 15 in long x 10 in wide" x 9 in high), 4-5 per box for a minimum of 7 days prior to the trial. A unique number was assigned to each snake with either an implantable transponder or permanent ink. Snakes were classified as juvenile if the snout-vent length (SVL) was 900 mm or less and as adults if the SVL was greater than 900 mm (McCoid, pers. commun., 1991).

Two commercial cargo shipping containers, each with one door opened, were used under tarpaulins outdoors. Each container was loaded with nonfood cargo (i.e., wood, cardboard boxes, metal drums) to simulate a typical, shipping test situation. The enclosed space under the tarpaulin for each container was 1,685 ft^3. Inside dimensions of the cargo containers were 19.5 ft long x 7.7 ft wide x 7.8 ft high. Two fumigation treatments (T) were initially tested: T1, 0 lbs of methyl bromide/1,000 ft^3 for 2 hrs (control); and T2, 1.5 lbs of methyl bromide per 1,000 ft^3 for 2 hrs. The doses and order for subsequent treatments were selected based on results from T2.

At the time of fumigation, 18 snakes were individually bagged in cloth bags and suspended by ropes from the ceiling along six rows near the top, middle, and floor of the container. Eighteen (18) snakes (13 juveniles, 3 adult males, and 2 adult females; or 13 juveniles, 4 adult males, and 1 adult female) were randomly assigned to each treatment. For each

treatment, the snakes were randomly assigned to one of 18 positions at the low (L), medium (M), and high (H) positions, as indicated in the below diagram.

Row	Left	Center	Right
6	M	H	L
5	H	L	M
4	L	M	H
3	M	H	L
2	H	L	M
1	L	M	H

Front of Container

Liquid methyl bromide from a compressed gas cylinder was delivered via a dispenser into a heated water bath to generate methyl bromide gas which passed through a hose into the test container, following the treatment procedures outlined in Section III of the Plant Protection and Quarantine (PPQ) Treatment Manual. Possible leakage of methyl bromide was monitored with a halide leak detector; a Self-Contained Breathing Apparatus (SCBA) was used while making this check. At approximately 30 min, 1 hr, and 2 hrs after methyl bromide introduction, concentration readings were determined with a calibrated Fumiscope®[1] from three sampling leads placed near the floor, center and top of the container.

At the end of the exposure period, containers were aerated by an exhaust fan. Draeger® methyl bromide detection tubes were used to ensure that the containers were safe (<5 ppm) for reentry by research personnel. Status of the snakes was recorded; survivors were returned to their cages and observed daily. Snakes that died during the fumigation tests were preserved in 10% formalin to be used for museum research purposes.

RESULTS

All snakes in Treatment 2 died within 18 hrs (Table 1). Because T2 was successful, the next logical step was to see if the same dose at a shorter duration was equally effective (T3). Similarly, a lower dose (T4) was used to provide comparative data to T3. T5 replicated T3. T6 reexamined the fumigant concentration from T4, but with a longer exposure period.

[1] Reference to trade names does not imply endorsement by the U.S. Government.

Table 1. Treatment, exposure period, and mortality of brown tree snakes fumigated with methyl bromide in simulated cargo containers in Guam during 1991 (*n* = 18 snakes/treatment).

Night	Treatment No.	Treatment	Exposure	Mortality: No. dead/ treated	Mortality: No. days to 100%
9/27	T1	Control	2 hrs	0/18	-
9/27	T2	1.5 lbs/1,000 ft^3	2 hrs	18/18	<1
9/28	T3	1.5 lbs/1,000 ft^3	1 hr	18/18	10.5
9/28	T4	.75 lbs/1,000 ft^3	1 hr	1/18	-
9/29	T5	1.5 lbs/1,000 ft^3	1 hr	18/18	9.5
9/30	T6	.75 lbs/1,000 ft^3	2 hrs	18/18	2.5

This study demonstrated that methyl bromide, at or below many currently registered application rates, consistently kills brown tree snakes in cargo containers. The application rate of 1.5 lbs/1,000 ft^3 for 2 hrs appears to be the schedule of choice because it resulted in 100% mortality, relatively quick kills, and would allow for variation in any commercial fumigation operation.

An interesting observation of this study was the apparent sensitivity of snakes to methyl bromide fumigation, as indicated by the results of the 0.75 lb/2 hr treatment. Of the numerous EPA-registered fumigation schedules for methyl bromide, all use at least the effective rates tested in the study, usually for much longer exposure periods. This suggests that most cargo fumigated with methyl bromide should not contain live snakes upon reaching its destination. However, in the event that snakes in cargo do not die within the time period of shipping, the data from T6 would suggest that they will not live long upon arrival at the cargo destination. Data from T3 and T5 would suggest that even if they are alive upon arrival, they will die eventually.

FOLLOWUP PROCEDURES FOR THESE DATA

Several additional steps need to be pursued with these data before methyl bromide can be used as a fumigant.

1. DWRC will prepare a data package by December 31, 1991, on the methyl bromide/brown tree snake study in Guam for submission to APHIS/Technology Support Staff (TSS), Hyattsville, Maryland. Documentation and records of the study will be archived at DWRC.

2. TSS will discuss potential label changes with Great Lakes Chemical Company, West Lafayette, IN 47906, and with other chemical companies holding methyl bromide registrations to determine if these companies are interested in adding brown tree snakes to methyl bromide label claims.

3. TSS will prepare a letter to transmit the data to Great Lakes Chemical Company and other interested companies, authorizing them to use the USDA/APHIS data to support label claims for the brown tree snake. The interested chemical companies will then submit the data and revised labeling to the EPA Registration Division for approval.

FUTURE FUMIGATION DEVELOPMENT

Based on the positive results of this trial, the following areas of cargo fumigant development will be considered for FY-92.

1. Select and evaluate one or two additional currently registered fumigants at currently registered rates and exposure times with the intention again of effecting a simple label change should it kill brown tree snakes in nonfood cargo. Potential fumigants include aluminum or magnesium phosphide tablets.

2. Evaluate the effectiveness of the methyl bromide product that is sold in 1.5-lb canisters and registered with EPA for fumigation. This product, if effective, might provide a logistically simple and inexpensive fumigation technique for cargo.

3. Evaluate methyl bromide canisters, and/or the previously mentioned phosphide products, as a means of fumigating noncombustible materials such as wire fencing, cement telephone poles, under tarpaulins in shipment areas. These and other such products or equipment apparently might not always be shipped in cargo containers, but loaded directly onto transport vessels.

ACKNOWLEDGMENTS AND COOPERATORS

This research was conducted under an Interagency Agreement (IA) titled "Methods for management of the brown tree snake" between the USDA/APHIS/S&T, Denver Wildlife Research Center, and the U.S. Department of the Interior, Fish and Wildlife Service (FWS), National Ecology Research Center. This IA, signed in July 1991, is to develop effective control techniques that can be used in an integrated pest management approach for the brown tree snake.

The successful implementation of this fumigation study in such a short time period was the result of excellent cooperation and assistance by many organizations. We wish to acknowledge them, particularly some key individuals: the Guam Department of Agriculture, Division of Aquatic and Wildlife Resources, including Mr. Mike McCoid; the U.S. Navy, including Capt. Gene Trimpert, Lt. Cmdr. Asa Page, and Mr. Charles Cruz; the FWS, including Dr. Thomas Fritts, Dr. Lisa Close, Mr. Craig Clark, Mr. Earl Campbell, III (FWS Coop Unit, University of Ohio), and Dr. Gordon Rodda (FWS Coop Unit, University of Arizona); Guam Environmental Protection Agency, Mr. Larry McCleary; No Ka Oi Termite and Pest Control (Guam), Inc., Mr. Joey Lopez, Sr.; APHIS, including Mr. Robert Berninger; Great Lakes Chemical Corporation; and the DWRC, including Dr. Clay Mitchell, Quality Assurance Officer, and Dr. Richard Engeman, Statistician. These individuals either assisted directly in carrying out the study or provided the information (in some cases, equipment) necessary to conduct it. Animal Damage Control personnel (Messrs. Gary Oldenburg and Saidor Turman) provided help in setting up test equipment.

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DRAFT

Consultant's Report*

BIRD PESTS IN ARGENTINA AND URUGUAY
SECOND REPELLENT CONSULTANCY

September 20-October 11, 1991

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ITINERARY

Date	Location	Activity
Sep 20-21	Denver, Colorado, to Montevideo, Uruguay	Travel
Sep 22	Montevideo, Uruguay, to Salto, Uruguay	Inez Arez, Roberto Villares, and Alberto Suares of Sanidad Vegetal, Uruguay, and I drove to Salto Grande Hotel for a conference.
Sep 23-27	Salto	Presented six lectures at the "Curso Binacional Sobre Manejo Integrado de Aves Plaga" for approximately 30 participants.
Sep 28	Salto to Parana, Argentina	Traveled with Ms. Maria Elena Zaccagnini, Dr. Enrique Bucher, and Ing. Agr. Oscar Arregoces by automobile; visited Nacional El Palmar Parque and observed parakeet nesting populations in palm groves.
Sep 29	Parana	Worked on consultant's report.
Sep 30	Parana	Visited Direccion Sanidad Vegetal for Entre Rios and staff at the National Institute of Agricultural Technology (INTA).
Oct 1	Parana	Visited Ministerio de Agriculture, Ganad, Industria y Comercio, Provincia de Santa Fe, including the director and several staff members. Discussed bird-agriculture conflicts in their province and chemical registration matters.
Oct 2	Parana	Worked in INTA office on two research protocols and plans for an aviary to be constructed.

Itinerary (Continued)

Date	Location	Activity
Oct 3	Parana	Visited Picazuro Pigeon damage to emergent sunflowers near Cnia.
Oct 4	Parana	Visited chemistry laboratories of Universidad Nacional del Litoral-- Faculty Quimica, Laboratorio Central de Servicios Analiticos, and Instituto de Desarrollo Tecnologico Para la Industria Quimica in Santa Fe.
Oct 5-7	Parana	Worked on reports, study protocols, aviary design, and a list of recommended equipment.
Oct 8-9	Parana to Cordoba, Argentina	Traveled to Cordoba and visited Universidad Nacional de Cordoba, Facultad de Ciencias. Met with Sanidad Vegetal personnel, visited a dove and pigeon roost, and participated in a mini workshop on future research.
Oct 9-10	Cordoba to Montevideo, Uruguay	Met with Uruguay Sanidad Vegetal representative to discuss details of Argentine consultancy.
Oct 10-11	Montevideo to Denver, Colorado	Travel

OBJECTIVES OF CONSULTANCY

The purpose of this consultancy was to complete the second segment of responsibilities as per the United Nations Food and Agriculture Organization (FAO) Project TCP/RLA/8965(A) "Integrated Control of Bird Pests" in Argentina and Uruguay, according to the Terms of Reference for Consultancy No. 10A "Nonlethal Chemical Control--Repellents (Fiedler report, May 25, 1990), as follows:

1. With assistance of Ms. Ethel Rodriguez, Head, Department of Bird Pests, Sanidad Vegetal, Ministry of Agriculture, Montevideo, Uruguay; Ms. Maria Elena Zaccagnini, Head, Bird Damage Control, National Institute of Agricultural Technology, Parana, Entre Rios Province, Argentina; and other specialists, complete review of bird problems and main geographic areas of concern.

2. Further develop awareness of the field crops and cropping patterns currently grown in the region and how they would affect chemical control strategies.

3. Gather additional information on current chemical control practices, the extent of their use, their efficacy, and safety.

4. Further assist the bird control specialists in defining bird problems in the area with respect to chemical or agronomic control methods and develop a strategy based on both long- and short-term studies.

5. Prioritize the short-term studies and assist the bird control specialists in designing the four or five top priority experiments.

6. Present three lectures on nonlethal bird damage control concepts in a training course held in Salto, Uruguay, for biologists and agronomists from Argentina and Uruguay.

7. Present three lectures on ecotoxicology, substituting for Dr. James Keith from the Denver Wildlife Research Center (DWRC), at the training course in Salto, Uruguay.

8. Prepare the consultancy report.

INTRODUCTION

This report is an extension of a July 31, 1991, report "Bird Pests in Argentina and Uruguay, Repellent Consultancy," from a visit to these countries between April 10 and May 3, 1991. In the July report, a background was given for the economically important bird pests--the Eared Dove (*Zenaida auriculata*), Monk Parakeet (*Myiopsitta monachus*), Spot-winged Pigeon (*Columba maculosa*), Picazuro Pigeon (*C. picazuro*), and miscellaneous blackbirds, ducks and finches. Crops and cropping patterns were summarized for sunflower (both as a primary and secondary crop), sorghum, maize, wheat, barley, soybean, and rice. Potential bird damage control applications, observed needs, and recommended experiments were also discussed.

The main mission of this trip was to lecture and participate in a training course "Curso Binacional Sobre Manejo Integrado de Aves Plaga" presented to approximately 30 biological students and agronomists from Argentina and Uruguay. Since only 2 days of the first trip were spent in Argentina, additional time was needed to view and discuss bird damage problems in agriculture. Finally, considerable time was spent in helping bird control specialists, Ms. Rodriguez and Ms. Zaccagnini, identify the four or five most urgently needed short-term studies and assisting in their study design.

During this second consultancy, additional information, new insights, and additional problems were discovered. The following is a report of the training course and a topical discussion of the economically most important bird species causing damage to agriculture crops in the binational region.

Course on Integrated Management of Bird Problems in Agricultural Crops

A 5-day binational training course "Curso Binacional Sobre Manejo Integrado de Aves Plaga" was held at the Salto Grande Hotel in Salto, Uruguay, an area located on the border between Argentina and Uruguay. Thirty-six participants, including instructors and students, attended from 15 institutions. The site, arrangements, curriculum, materials and student participation were all excellent. The curriculum (Attachment 1) was designed to instruct participants in the main points involved in integrated management and to guide them through appropriate thought processes toward finding solutions to their respective problems. The organizers are to be commended for the quality of materials and equipment available, the professional handling of the course, and all of the arrangements.

I presented six lectures at the training course. The topics included nonlethal methods of bird damage control, bird repellents, general ecotoxicology concepts, ecotoxicology applications, and the environmental implications of pesticide residues and general aspects of their measurement.

Eared Dove

Considerable time was spent with Dr. Enrique H. Bucher, Department of Zoology, University of Cordoba, Argentina, who shared his insight on the Eared Dove. Dr. Bucher has extensively studied the Eared Dove near Cordoba in an area of arable cultivation interspersed with secondary thorn scrub. While dove breeding in Uruguay occurs mostly from November to March (averaging two or three clutches per year, De Grazio 1975), food supply through the larger arable farming schemes has enabled the breeding season to begin in August or September so that reproduction occurs during about 10 months (Bucher 1974, Murton et al. 1974). While most of the breeding takes place in the spring and summer, active nests have been found all during the year (Bucher and Orueta 1977). Males with distended testes and spermatogenic activity as well as active nests have been found throughout the year; no photoperiodic control of breeding has been observed in this region (Bucher, pers. commun.). Thus, the opportunistic breeding readiness is there, and breeding can be initiated very suddenly if appropriate conditions occur (i.e., adequate food supply). During a period of very high Eared Dove populations, one breeding pair of doves produced six successive clutches (Bucher, pers. commun.). Bucher (1986 and pers. commun.) claims that doves respond with a dramatic buildup in population levels to the following key factors: (a) year-round increase in food availability (i.e., grain crops) over a critical proportion (~70%) of the landscape surface, (b) availability of patches of habitat suitable for colonial breeding, and (c) availability of water sources. Since there is no shortage of (b) or (c) in the binational area of focus, Item (a) should be investigated to see whether there has been a significant shift in cropping patterns and, if so, the effect of this shift on year-round food availability for the Eared Dove.

Changes in food availability through changes in farming practices can have a very dynamic effect in lowering dove numbers. A good example is the Cauca Valley of Colombia where changes in farming practices alleviated a serious Eared Dove damage problem to cultivated crops that had existed 3 years earlier (Ramakka and Ramakka 1979). Indeed, changes in Eared Dove damage patterns within Cordoba Province provide a similar example. Damage has been decreasing in recent years. Concurrently, farmers are planting less sorghum, more soybeans, and grain threshing efficiency is improving, all of which may mean less food availability. Farmers now are more concerned with damage to emergent soybean seedlings (Bucher 1986 and pers. commun.).

Damage patterns in western Uruguay and the Entre Rios Province of Argentina now tend to be more localized and difficult to define. Some farmers suffer heavy Eared Dove damage to their crops even though none of the consultants from Denver have observed large numbers of Eared Doves that would be likely to cause heavy damage to crops. Visits to two roosts near Parana, Argentina, (Entre Rios Province) on October 2, 1991, indicated low numbers of birds (Bucher, pers. commun.). Individual or small groups of birds (<10 individuals) were observed throughout the travels through the countryside indicating dispersed rather than colony patterns for roosting/nesting in these areas. Active Eared Dove nests have not been observed in the Entre Rios Province during the winter.

Farming schemes are more diversified and have a greater percent of the land devoted to livestock production in the Entre Rios Province and western Uruguay than in the Cordoba Province, Argentina. However, in the Cordoba Province, most of the land previously devoted to sorghum production is now being planted to sunflower, a crop even more nutritionally beneficial and therefore more attractive to the Eared Dove. A serious need exists for research to be conducted there in defining and finding solutions to this very complex situation that is developing. Answers to many of these questions will be applicable to other similar situations around the world.

Monk Parakeet

The Uruguayan Monk Parakeet damage control campaign is now on hold due to (1) a desire to replace endrin in the grease formulation and (2) considerable controversy on funding regulations. In the latter case, there are too many instances where the individuals paying for the campaigns have nests but no crop damage; on the other hand, crop growers receiving the benefits often do not have nests and consequently pay nothing.

The Entre Rios, Santa Fe, and Cordoba, Argentine campaigns continue on a smaller scale than in the past using carbofuran in grease, even though such use is illegal. Parakeet populations throughout the region are increasing because the control campaigns have not been operative for the last year or two. For example, one consultant visited San Jose de Feliciano in the northern part of the Entre Rios Province where livestock production predominates. In this area, only about 300 ha of cultivated crops (mainly maize) are distributed among several low-income farmers in fields approximately 10 ha. Their maize crops are being destroyed; therefore, most of these farmers who were interviewed indicated that, in the future, they will be planting sweet potatoes instead of maize to avoid parakeet damage. The livestock ranchers (many of whom do not live there) are assessed costs for parakeet campaigns, but most ignore the citations knowing that they will not be enforced.

Once the campaigns are fully renewed, they should be supported with damage assessment information that justifies the need in each area. Massive and generalized campaigns that cover areas in which damage is not of economic significance to farmers should be avoided.

There is much interest in CPT (3-chloro-4-methylbenzamine) or CPTH as a replacement for endrin in Uruguay and carbofuran in Argentina as well as for automobile grease used as a carrier in both countries. It is hoped that CPT or CPTH will be a safer (more specific) chemical, and silicon dioxide gels can replace the grease currently used. This will allow using less chemical, which will hopefully degrade more quickly in the environment. A study protocol outline was written to be used for research required to test this hypothesis.

The repellent properties of Avitrol (4-aminopyridine-HCl) should be considered for Monk Parakeet control in situations where the control campaigns do not operate. It is an excellent tool that when used under proper conditions (Sultana 1985, Knittle et al. 1988) can be effective in protecting agricultural crops.

Pigeons: Spot-winged and Picazuro

In the Entre Rios Province, the most discussed bird problem is perceived to be losses of emergent sunflower and soybean seedlings to the Picazuro and Spot-winged pigeons. Studies conducted in 1975 (Calvi et al. 1975, Calvi et al. 1976) indicated 0.25% methiocarb-treated soybean seeds were very effective against the pigeons. A study protocol outline was drafted to test 0.25% methiocarb-treated sunflower seeds. Another study protocol outline was drafted to treat the cotyledons with methiocarb after emergence if damage reduction data from the seed-treatment do not confirm the earlier studies.

One troubling landscape characteristic (probably contributing to this problem) is the loss of livestock pastures (discussed elsewhere) to undesirable trees and brush. Presumably, this increases nesting/roosting habitat for pigeons as well as reducing grass resources for livestock production.

Crops and Cropping Patterns

Sunflower

During this trip I continued to interview and question other experts for solutions as to why sunflower crops are grown continuously from January in Argentina through May in Uruguay, thus making a 5-month sunflower supply available for Eared Dove damage. Accordingly, sunflower, the favored cash crop in the region, has also become the favored food for Eared Doves. This continuous supply of high quality food for such a long time period is conducive to increased Eared Dove populations and increased crop damage. Argentine agronomists cannot understand why Uruguayan farmers do not plant more primary sunflowers at an earlier date so that a gap would occur in this food supply available to doves. On the other hand, Uruguayan agronomists have a myriad of reasons for their current sunflower cultivation practices.

As discussed in my previous report (July 31, 1991), the percent of primary to secondary sunflowers has decreased in the last few years for some of the following reasons: (1) the only certified seeds available now must be obtained from Argentine suppliers; these seeds have been developed for the more sandy Argentine soils; (2) the seeds are very expensive; comparative costs for Uruguayan and Argentine farmers should be obtained; (3) farm machinery and petroleum costs are higher for Uruguayan farmers; (4) Uruguayan farmers must complete with a much larger export market (Argentina) in selling their product; and (5) farmers in both countries like to plant secondary crops following the wheat harvest, but Argentina has an excellent export source for soybeans, while Uruguay does not. In addition, Uruguay does not have any processing plants for refining soybean oil products to a quality suitable for cooking purposes.

Instead, the Uruguayan farmers plant low quality, open-pollinated sunflowers. Thus, rather than making a large monetary investment in primary sunflowers, the trend has been for Uruguayan farmers to plant more secondary sunflowers. They use low cost poor quality seeds, do little to

prepare the soil, do not fertilize or apply insecticides or herbicides, and hope that conditions will be good enough that they might afford to harvest the crop. If fate turns against them, the plants are left strewn for a long period of time. In either case, the Eared Dove benefits by an abundant supply of nutritious food.

The justification that Uruguayans use for planting secondary sunflowers seems overwhelming. One action that could reverse the trend back to their planting more primary sunflowers would be for plant breeders from the National Institute of Agricultural Investigations (Instituto Nacional de Investigacion Agropecuaria [INIA]) in Uruguay and the National Institute of Agricultural Technology (Instituto Nacional de Technologia Agropecuaria [INTA]) in Argentina to (1) find varieties that do well in the heavier clay soils of Uruguay, (2) encourage private seed companies or cooperatives to increase the supply of hybrid seed, and (3) sell it at a price favorable to farmers. INIA is currently screening Argentine genotypes (refer to my July 31, 1991, report), but the process should be accelerated.

There has been an increasing effort to move from striped sunflower varieties to black ones in Argentina, the drive being toward greater oil percentages (see page 7 and Appendix I of my July 31, 1991, report). One incentive for this may be an upward movement of the oil percentage threshold value (currently 43%) used by buyers in setting higher prices for the product. It is unlikely that striped varieties will reliably produce crops with much higher percentages of oil. Two factors in favor of striped sunflowers, however, are that (1) they have a higher yield and (2) they seem more resilient to farming subtleties than the black-hulled genotypes.

In the Entre Rios Province, the damage to emergent sunflower seedlings by pigeons (see p. 7 of this report) is considered to be very important. Mesurol would appear to be the appropriate chemical, and two study protocols have been written for proposed studies.

Livestock Pasture Dilemma

Some of the Entre Rios Province has a serious problem with steady encroachment of undesirable trees (mainly *Acacia* spp.) and brush (Bucher, pers. commun.). Seeds from these species are consumed by cattle and spread about the pasture in piles of manure. If the roots are not either removed or killed, the plants will grow back. Apparently, most of the farmers are not aware that 30-40% of their pasture grasses have already been lost through this encroachment. Not only are they losing livestock carrying capacity, but an excellent nesting/roosting habitat is being generated for pigeons and doves, which eat and damage their crops.

We visited the Cnia area of the Entre Rios Province, which has been heavily planted to sunflower in recent years. In 1990, pigeon problems to emergent seedlings were so serious that the farmers began using poison baits. Farms in the Cnia area comprise at least 50% livestock pastureland that surrounds the crops. Most pastures were heavily infested with undesirable acacia and thorn shrubs. Some farmers have been clearing their pastures, and wood had been cut into stove lengths and neatly piled. Since there is much wood burning here for cooking and heating, the wood retrieved is of monetary value. An important research problem would be to study the monetary

benefits of such practices to (1) increasing livestock carrying capacity, (2) generating usable energy resources, and (3) decreasing bird damage to nearby cultivated crops.

Pesticide Chemicals--Present and Future

Pesticide use, importation, and registration practices in both Uruguay and Argentina were discussed in the September 16, 1991, report of Dr. James O. Keith. Once registered in the United States, a chemical can begin through the registration process in Argentina, and the Argentines will conduct two or three tests in three or four situations. Experimental use permits will be available from the Argentine government to test other chemicals that are not used in the United States. Of course, most of the vertebrate pest control chemicals are for minor use; they do not have enough market value to stimulate interest among chemical companies.

In Argentina new pesticide registration and use guidelines were expected to be signed in October 1991. The Santa Fe Province had an important role in designing and testing enforcement concepts that will appear in the new laws. Previous laws have been disregarded because national governments have not had the staff, transportation, etc., to travel the countrysides to enforce them. The new laws will require pesticide use permits, which must be obtained prior to use from the department city (equivalent of county seat in the United States) in each province.

It appears that both countries have the analytical chemistry capabilities to monitor pesticide activities. Both countries have enough gas and high performance liquid chromatographs and detection capabilities to analyze soil, water, and vegetation samples for pesticide residues. The Universidad Nacional del Litoral (UNDL) Faculty of Chemistry in Sante Fe, Argentina, are official inspectors for Argentine exports--both from agriculture and industry. They test meat, milk, and grain products for pesticides and follow Quality Control guidelines that are comparable to those used by the Food and Drug Administration in the United States. Before they can sell any of their products to the United States, the laboratory as well as the produce must be inspected by U.S. inspectors, and the product be found acceptable.

In addition, the UNDL has ties with the Instituto de Sarrollo Technologico--Para la Industria Quimica (an industrial chemical technology institute), which also works with another institute in the same building, Central de Servicios Analiticos. Both institutes have recent (late 80's) state-of-the-art instrumentation. All three laboratories (UNDL and the two institutes) have enough equipment but are not heavily staffed.

Apparently laboratory supplies and instrument parts are available. The U.S. companies that sell instrumentation also install equipment and, at that point, the respective instrument is under warranty. These companies also hold workshops from time to time on maintenance and applications of their equipment. Unfortunately, when some of the more elaborate and expensive instruments (i.e., mass spectrometers) not under warranty break down with a problem that the UNDL technicians cannot solve, it costs the UNDL several thousand dollars to bring in a repairman from the United States.

The equipment and expertise are available for conducting acetylcholinesterase (AChE) tests which are used to monitor use of some pesticides, but appropriate contacts and all proper dialogue will be important to get a program under way. Another ecotoxicologist consultancy should be planned in late 1992 for this purpose. While, with trained personnel and proper equipment, this test can be conducted in the field as well as laboratory, it was felt that some facility should be contacted that would take an active interest in overseeing the establishment of AChE testing in the binational area and that would also help other laboratories develop the methodology. Two possible contacts are (1) Dra. Elisa Kacsan, Laboratoria de Toxicologia, Hospital I. M. Cullen and (2) Dr. Marcelo Rubio, Catedra de Toxicologia y Farmacologia, Facultad de Agrononia y Veterinaria Resperanta, UNDL.

The library available for the two institutes was in good condition, with the exception that decreasing funding and increasing periodical costs have caused them to have to cut back subscriptions from 70 to less than 30.

In discussions among three consultants, it was agreed that the equipping and staffing of a super laboratory at the Salto Grande binational site for control would probably not be as wise as directing resources and activities into the network of laboratories throughout the two countries. Staffing, training, and some equipment provided these laboratories through the program funding would be mutually beneficial to both parties, whereas building a massive program at one site that would probably die after 5 years would seem to be a poorer investment in time and money.

Recommendations for Action

A long list of recommended short- and long-term studies was included in my July 31, 1991, report, This list will not be reiterated here other than to emphasize problem areas which should receive attention.

Alternative chemical formulation for Monk Parakeet control:

A study protocol outline was generated for the studies necessary to test CPT and CPTH as toxicants in a modified formulation. Amorphous silicon gels made from vegetable oils will be compared with automobile grease as carriers. The DWRC has made necessary arrangements to ship both chemicals to Argentina and Uruguay so that the studies can begin in December.

Pigeon damage to emergent sunflowers and soybeans in Argentina:

Study protocol outlines were generated for two possible sequential studies. (1) The first would be to test methiocarb seed treatments for protecting emergent sunflowers seedlings from pigeon damage. If the results do not corroborate those obtained on soybean seedlings by Calvi et al. (1975), then (2) an aviary study would be conducted on topical treatments of methiocarb. Methiocarb is not available in Argentina and would have to be obtained from Uruguay.

Use of CPTH toxic baits for Eared Dove control in specific situations:

In some situations in restricted locations, the population of local birds damaging crops can be decreased and crop losses reduced. In the United States, CPTH has been useful for these situations because of its specificity for the depredating birds. We do not know if the same potential exists for use of CPTH for baiting the Eared Dove. A study protocol outline has been developed for conducting these studies. The chemical (see discussions above) and personnel are needed for these studies.

Build aviary facilities for conducting avian research:

The bird control specialists in both countries (Montevideo, Uruguay, and Parana, Argentina) do not have adequate aviary facilities to conduct needed research studies. Some general guidance was given the Argentine specialist, but a detailed plan and funding is needed in both countries.

Establish the capability of conducting acetylcholinesterase assays:

A method for determining acetylcholinesterase activity in blood and brain tissue was provided to the Argentine bird control specialist. This is important for future ecotoxicological studies. Two centers were identified which could implement this technique, once trained. An ecotoxicologist consultancy should be arranged in late 1992 to help get the program under way.

Additional Research Involving Extension:

1. Farming practices

   Improper land preparation and poorly functioning or calibrated planting and harvesting machinery are the sources of greater losses than bird damage in many areas. Uneven seed distribution during planting (i.e., skips in rows some places and excess density of plants in others) was observed in fields. Harvesters that do not recover the expected percentage of seed during threshing are contributing also to increased bird populations (Bucher and Bedano 1976, Bucher and Nores 1976). Perhaps harvesting losses can be decreased by recommending that the harvester operator be paid a bonus for a certain level of grain recovery. There is a need to determine the frequency and extent of these losses.

2. Livestock Pasture Management (see p. 8)

   In the Entre Rios Province, poor pasture management is contributing to the loss of livestock carrying capacity and an increase in habitat for doves and pigeons, which probably feed in adjacent cultivated crops. A study should be conducted on one or two large ranches in the area having about 60-70% in pastureland and the remainder in sunflower and wheat. Bird populations, damage assessments, and crop production would be assessed for 2 years; then the pasture would be cleared at the expense of project funding and the same crop

assessments made during the following 2 years. The extension system would be responsible for reporting the results to farmers.

3. Helping Uruguay Produce Its Own Certified Hybrid Sunflower Seeds (see p. 8)

   Uruguay needs to begin to produce its own hybrid sunflower varieties that have been adapted to its soils. INIA is testing Argentine lines, but the process leading to Uruguayan seed production should be speeded up. INTA (Argentina) should help in this effort, and both INTA and INIA should be encouraging involvement of seed companies such as Dekalb, Asgrow, Northrup-King, and Corgil as well as Uruguayan cooperatives. Extension arms of both Sanidad Vegetal, INIA, and INTA should be involved and get the message to farmers concerning benefits in planting primary crops earlier in the year than has been done in the past.

Final Thoughts

Since 1973 (Mott trip report), there have been several trips to this region by consultants studying bird damage problems in agricultural crops. Many of them have made the same research recommendations that are found in the consultancy trip reports for this FAO Project TCP/RLA/8965(A) "Integrated Control of Bird Pests." With the comprehensive interdisciplinary coverage and the excellent training provided in the "Curso Binacional Sobre Manejo Integrado de Aves Plaga," we hope that the groundwork has been laid for much-needed, longer-term applied research directed to solving these problems.

An important aspect of implementing this project depends on good cooperation and participation of scientists of both countries. Uruguayan INIA personnel should be encouraged to participate in any future training. Scientists from the two Sanidad Vegetals, INTA, and INIA should be in frequent contact to find common solutions to the agronomic-wildlife biology challenges that are common between the two countries.

Through the FAO consultancies and training course, several specialists from numerous fields, each viewing the problem from his or her own perspective, have shared their knowledge and recommendations. This expertise has been intended to be a stepping stone toward well-organized, progressive changes (i.e., food supply to the Eared Dove, nesting habitat for pigeons, control campaign practices for the Monk Parakeet) that should affect numbers and feeding locations of depredating species. Yes, there are a number of concepts and methods that can be immediately applied to trouble spots; but the lasting value of this work will be in the applied research, professional training, and extension research that reveal the larger picture of agricultural and environmental practices.

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15:00 - 15:45	PRACTICA: Estudio de residuos.	Roger Bullard
15:45 - 16:15	**Intervalo.**	
16:15 - 17:00	COMUNICACION Conceptos generales.	Oscar Arregoces
17:15 - 18:00	PRACTICA: Planificación comunicado.	Oscar Arregoces

DIA 5

08:00 - 08:45	CAMPAÑAS: Conceptos Generales.	Maria I. Ares
09:00 - 09:45	CAMPAÑA: Lucha Contra la Cotorra.	Julio Medvescigh
09:45 - 10:15	**Intervalo.**	
10:15 - 11:00	PRACTICA: Discusión campaña de cotorra	Ethel Rodriguez y Julio Medvescigh
11:15 - 12:00	CAMPAÑA: Lucha contra las Palomas.	Ethel Rodriguez
12:00 - 14:00	**Almuerzo.**	
14:00 - 14:45	PRACTICA: Discusión campaña contra palomas.	Ethel Rodriguez y Maria E. Zaccagnini
15:00 - 15:45	EVALUACION FINAL	Ethel Rodriguez y Maria E. Zaccagnini
15:45 - 16:15	**Intervalo.**	
16:15 - 17:00	MESA REDONDA	Ethel Rodriguez y Maria E. Zaccagnini
17:15 - 18:00	ACTO DE CLAUSURA	Felipe Canale y Diana Guillén

Curso Binacional Sobre Manejo Integrado de Aves Plaga

PROYECTO DE F.A.O. TCP/RLA/8965

FECHA: 23/27 DE SETIEMBRE
LUGAR: SALTO GRANDE, URUGUAY
AUSPICIA: F. A. O.

ORGANIZAN: DIRECCION DE SERVICIOS DE PROTECCION AGRICOLA
MINISTERIO DE GANADERIA AGRICULTURA Y PESCA (R.O.U.)

DIRECCION DE PRODUCCION Y COMERCIALIZACION
AGRICOLA DE LA SECRETARIA DE AGRICULTURA Y PESCA (R.A.)

PROGRAMA DE ACTIVIDADES

DIA 1

08:00 - 08:45	ACTO DE INAUGURACION.	
09:00 - 09:45	INTRODUCCION.	Oscar Arregocés
09:45 - 10:15	**Intervalo.**	
10:15 - 11:00	EVALUACION INICIAL.	Ethel Rodríguez Maria E. Zaccagnini
11:15 - 12:00	BIOLOGIA Y DINAMICA: Conceptos generales.	Centro de Zoología Aplicada
12:00 - 14:00	**Almuerzo.**	
14:00 - 14:45	PRACTICA:Identificación de especies.	Claudia Mathern
15:00 - 15:45	BIOLOGIA Y DINAMICA: Palomas.	Centro de Zoología Aplicada
15:45 - 16:15	**Intervalo.**	
16:15 - 17:00	BIOLOGIA Y DINAMICA: Palomas.	Centro de Zoología Aplicada
17:15 - 18:00	PRACTICA: Modelo Poblacional de palomas.	Joaquin Navarro

DIA 2

08:00 - 08:45	BIOLOGIA Y DINAMICA: Cotorra.	Centro de Zoología Aplicada
09:00 - 09:45	BIOLOGIA Y DINAMICA: Cotorra.	Centro de Zoología Aplicada
09:45 - 10:15	**Intervalo.**	
10:15 - 11:00	PRACTICA: Modelo poblacional de cotorra.	Joaquin Navarro
11:15 - 12:00	BIOLOGIA Y DINAMICA: Otras aves plaga.	Centro de Zoología Aplicada
12:00 - 14:00	**Almuerzo.**	
14:00 - 14:45	EVALUACION DE DAÑOS: Conceptos Generales.	Maria E. Zaccagnini
15:00 - 15:45	EVALUACION DE DAÑOS: Casos Especiales.	Maria E. Zaccagnini
15:45 - 16:15	**Intervalo.**	
16:15 - 17:00	PRACTICA: Evaluación de daños.	Maria E. Zaccagnini

DIA 3

08:00 - 08:45	MANEJO: Conceptos generales.	Enrique Bucher
09:00 - 09:45	MANEJO: Habitat.	Maria E. Zaccagnini
09:45 - 10:15	**Intervalo.**	
10:15 - 11:00	MANEJO: Habitat.	Maria E. Zaccagnini
11:15 - 12:00	PRACTICA: Habitat, características agro-ecológicas.	Maria E. Zaccagnini
12:00 - 14:00	**Almuerzo.**	
14:00 - 14:45	MANEJO: Control letal.	Ethel Rodriguez
15:00 - 15:45	MANEJO: Control letal.	Ethel Rodriguez
15:45 - 16:15	**Intervalo.**	
16:15 - 17:00	PRACTICA: Control letal.	Ethel Rodriguez

DIA 4

08:00 - 08:45	MANEJO: Control no letal.	Roger Bullard
09:00 - 09:45	MANEJO: Control no letal.	Roger Bullard
09:45 - 10:15	**Intervalo.**	
10:15 - 11:00	PRACTICA: Control Repelentes.	Roger Bullard
11:15 - 12:00	ECOTOXICOLOGIA Conceptos generales.	Roger Bullard
12:00 - 14:00	**Almuerzo.**	
14:00 - 14:45	ECOTOXICOLOGIA Ejemplos.	Roger Bullard

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ITINERARY

Date	Location
James O. Keith, Michael L. Avery, and G. Keith LaVoie	
Oct 6-8	Traveled from United States to Agadir, Morocco (Keith and LaVoie departed from Denver, Colorado) (Avery departed from Gainesville, Florida)
Oct 9	Traveled from Agadir to camp near Guelmim
Oct 10-22	In camp, conducted work on experimental area to be used in research during early 1992
Oct 23	Traveled from camp to Agadir
Oct 24	In Agadir
Oct 25	Traveled from Agadir to Casablanca
Oct 26-27	Traveled from Casablanca to United States (Keith and LaVoie returned to Denver, Colorado) (Avery returned to Gainesville, Florida)
Patricia C. Matteson	
Oct 12-13	Traveled from Ames, Iowa, to Agadir, Morocco
Oct 14-19	Conducted training course on identification of terrestrial insects
Oct 20	Traveled from Agadir to camp
Oct 21-22	In camp, worked on experimental area
Oct 23	Traveled from camp to Agadir
Oct 24-25	In Agadir
Oct 26-27	Traveled from Agadir, Morocco, to Ames, Iowa

ACTIVITIES AND FINDINGS

The objectives of October fieldwork in Morocco were (1) to familiarize American and Moroccan scientists with the region where the study area is located (Fig. 1), with the experimental plots, and with the flora and fauna of the area; and (2) to test the suitability of methods proposed for use in research during early 1992.

The study area (Fig.2) is near the deserted Fort Bou Jerif on the Oued Assaka about 20 km west of Guelmim. The site is rolling hills of desert terrain ranging in elevation from 90 to 200 m above sea level. Soils are rocky. The vegetation consists of 4 to 8 dominant shrubs and annual grasses and forbs that appear after the rains in November and December. The area is used by nomadic Berbers who graze sheep, goats, burros, and camels. Residents of small villages also graze livestock and harvest honey from bees that are abundant on the area.

The study area encompasses about 100 km^2 and contains 9 study plots, each 1.5 x 2.0 km. The 9 plots are located in 3 blocks (A, B, and C) of 3 plots each. Each plot within a block will receive one of three treatments: control (C), malathion (M), or dichlorvos (D). Thus, within the 3 blocks, each treatment will be replicated 3 times. A schedule for experimental treatment of plots and research activities during January and February 1992 is shown in Figure 3.

Establishment of Experimental Plots

In September, Mr. John McConnell and a survey team from the Ministry of Agriculture in Guelmim established the 9 experimental plots in the study area. In the central 0.5- x 1.0-km area of each plot (Fig. 4), rock cairns were built to mark each of the 15 bird-count points (Fig. 5). These 15 cairns were painted orange and blue. Blue cairns were built between the bird-count points to aid in orientation, to help in locating adjacent bird-count points, and to define boundaries of the mammal trapping areas (Fig. 6).

Mr. McConnell and workers from the Locust Control Center in Aït Melloúl established a large tent camp to house and feed the 18 Moroccans and 5 Americans that arrived for fieldwork (Table 1).

Entomology Session (Patricia C. Matteson)

Training

A 6-day training course was held for 10 Government of Mororro (GOM) trainees at the Centre National de Lutte Antiacridienne, Inezgane. Most of the course work was done in a laboratory with binocular dissecting microscopes. Teams of two or three trainees shared each microscope. That would have been a major hindrance except that more than half of the trainees were not entomologists and the relatively inexperienced trainees benefited from

the expert guidance of their colleagues when using unfamiliar technical terms and specialized scientific keys.

The consultant gave a ballpoint pen, notebook, dissecting probe, and plastic foam flats (for holding pinned insect specimens) to each trainee. Three textbooks were distributed to, and used by, every trainee:

Delvare, G. and H.-P. Aberlenc. 1989. Les Insectes d'Afrique et d'Amérique Tropicale. Clés pour la Reconnaissance des Familles. CIRAD/PRIFAS, Montpellier, France.

Roth, M. 1980. Initiation à la Morphologie, la Systématique et la Biologie des Insectes. ORSTOM, Paris, France.

Chinery, Michel. 1988. Insectes d'Europe Occidentale. Arthaud, Paris, France.

Six handouts were distributed to each trainee: "Major Natural Enemies of Locusts and Grasshoppers" (written by the consultant for the October 1990 Aït Baha training under this project); a pictorial key to the order Diptera; an article on the biology of the beetle *Trox procerus* (a major natural enemy of acridids); and descriptions of the three insect families Nemestrinidae and Calliphoridae (Diptera) and Chleridae (Coleoptera), including notes on genera and species of special interest.

The teaching collection of insects used in the course was made by the consultant in Iowa and Chad during July/August 1991. The consultant had hoped to present display specimens of the particular insect genera and species that are important natural enemies of acridids in the Mediterranean region. However, none of five museum/specialist sources contacted 3 months in advance provided specimens in time.

Each day the class schedule was approximately as follows:

<u>a.m.</u> <u>Laboratory</u>

1. Introduction of the insect groups to be covered
2. Trainees keyed specimens under consultant's supervision, using keys in Roth (1980) and Delvare and Aberlenc (1989), and referring to illustrations in Chinery (1988).

<u>p.m.</u> <u>Trainees finished keying specimens</u>

3. Each of the four trainee teams made a list of diagnostic characteristics for the insect groups covered, with emphasis on visual identification in the field.

<u>Conference room</u>

4. Consultant presented a briefing, showing slides on each insect group covered that day. Trainee teams presented their lists of diagnostic characteristics for each group. A discussion was held, and master lists were agreed upon. The master lists were

to be edited by the consultant and placed in an illustrated handout to be given to GOM participants during the January/February 1992 Bou Jerif field experiment.

The insect groups covered are listed in Table 2.

Evaluation of Training

At the end of the course (October 19), trainees were asked to give a grade from 1 (very bad) to 5 (excellent), with comments, to four aspects of the course:

Aspect of the training course	Average grade (eight responses)
1. **Organization**	4.75
2. **Time allowed for completion of work**	2.75
3. **Content of course (Which information was new for you? Which could be dropped?)**	4.00
4. **Utility course (Will the course be useful to you professionally?)**	4.75

1. **Organization** — 4.75

   Favorable comments were made about pairing non-entomologists and entomologists in teams, the quality of supervision of course work, and the richness of documentation (textbooks and handouts).

2. **Time allowed for completion of work** — 2.75

   Several trainees thought the time allowed for course work was too short, particularly for the non-entomologists. Partly because long periods of microscope work and keying can be fatiguing, trainees said that the course work should have been extended over 10 days or 2 weeks.

3. **Content of course (Which information was new for you? Which could be dropped?)** — 4.00

   One trainee noted that little briefing information was given on insect morphology and biology. Some of the course content, particularly keying insect specimens to order and the characteristics of the insect orders, was review for the entomologists among the trainees. However, only one of the trainees had studied the diagnostic characteristics of insect families before these sessions. In general, they expressed satisfaction with the course.

4. **Utility course (Will the course be useful to you professionally?)** — 4.75

   It is very important for non-entomologist (generalist) agricultural scientists to be able to identify insects to order, and for entomologists to identify insects at the family level. This course was a first opportunity for most of the trainees to learn those skills. They noted that the course content filled a practical need for many other aspects of their work in addition to pesticide side-effects studies.

There were several good suggestions for improving the course which, when taken in sum, would entail lengthening it substantially and including an insect collection aspect.

1. Trainees should be given materials and instructions for making their own collections of local insects, identifying the specimens using order and family keys.

2. More orders of insects should be listed, and study key orders should be described in greater depth--particularly with reference to biological information and number of families covered.

3. A reference collection should be available so that trainees could better visualize the diagnostic characteristics of orders and families.

Preparation for Locust Insecticide Ecotoxicology Field Experiment

After participating in skills development training, the consultant and the GOM entomology trainees joined the DWRC/GOM ornithology and mammalogy groups at the Bou Jerif experimental site. On October 22, the entomology team was shown the experimental area. Following the tour, a team discussion and planning session was held (with the consultant and Dr. James Keith) in preparation for the January/February 1992 field experiment. The entomology team and the other teams presented their reports during the general review/discussion chaired by Dr. Keith before everyone left Bou Jerif on October 23.

Entomology experimental activities remain essentially as described in the Study Plan (DWRC, December 9, 1991). Further planning decisions made at the Bou Jerif meeting included the following:

1. The entomology group will not participate in general carcass searches during the 2 days after each insecticide application. Rather, they will be occupied with sampling "knockdown" of arthropods and with an application-period sample of control plots.

2. An expert beekeeper (supervisor) and 3-9 observers are needed for honeybee monitoring, which will take place 4 days before and 4 days after the insecticide applications. GOM counterparts said that an excellent Moroccan specialist could help if USAID arranged for assistance through Mr. Arifi and that students or unemployed technicians could be engaged as observers for 100 dirhams/day.

3. Insecticide impact on honeybees is a major interest of the GOM. This justifies devoting considerable scope and care to the honeybee portion of the field experiment. The entomology group resolved that, if possible, 18 rather than 9 beehives should be obtained for the experiment. Then 2 hives could be placed on each experimental plot, allowing replication. With only 9 hives, recognizing that some hives will probably be lost in the course of the experiment,

observations will be made on 3 hives in each of the 3 plots in 1 block. Results of such unreplicated observations cannot be extended to other localities or insecticide applications with scientific confidence.

4. The consultant and three Moroccan entomologists (El Fayq, Mouhim, and Ghaout or Baou) will arrive at Bou Jerif on January 20, several days before the experiment begins. This team will learn from the ornithology specialists as soon as possible which insect groups are key diet items for breeding birds, so that those insects can be targeted in the entomology sampling program. The team will also observe insect populations in the field and carry out exploratory sampling in order to choose further insect groups for sampling. Appropriate sampling techniques, a sampling protocol, and a work schedule also will be developed.

5. In addition to honeybee and "knockdown" observations, insect population sampling will be carried out 9-5-1 days before insecticide application on each set (3) of treatment plots and 2-6-10 days after application. The draft sampling protocol will be tried out on a pilot basis during the first round of sampling and then modified as necessary.

An entomology field activity diagram for the experiment is Figure 7.

The consultant inventoried entomology supplies and equipment on hand in camp and in storage, and he discussed field experiment procurement requirements with Moroccan counterparts. A detailed listing of equipment and supplies still to be procured in the United States and in Morocco is part of this consultant's 10/30/91 memorandum to Mr. Joe Kitts.

Followup Activities Required

Edit illustrated French-language handout on the identifying characteristics of terrestrial insect orders and families commonly monitored in pesticide side-effects studies. The handouts are to be given to GOM participants at Bou Jerif.

Mammal Surveys (G. Keith LaVoie)

The objectives of mammal surveys were to determine the kinds of species present on plots, test methods for sampling abundance of species, and recommend methods for use in research.

Methods Evaluation

Wild mammals caught or observed on the study area are given in Table 3. The two dominant rodent species, *Psammomys obesus* (fat sand rat) and *Meriones shawi* (Shaw's jird), were virtually always found in drainages or

depressions. This habitat preference produced a clustered distribution of these species. We decided to trap in the plot borders and adjacent areas to avoid reducing the number of small mammals in the sampling areas.

We trapped for 913 trap nights on or near four of the plots during this training phase. Traps were checked morning and evening each day. Following the experimental protocol, we initially set out two trap-bands of 200 m, each consisting of 20 stations spaced about 10 m apart. One rat trap and 2 mouse traps were set at each station. Trapping success was extremely poor (Table 4), and about half of the traps were stolen during the first night. Thereafter, we trapped in less obvious areas and varied the number of rat and mouse traps with rodent sign, which was usually the active burrows of the fat sand rat and the jird. However, trapping success remained low. A large percentage of our mouse traps were sprung by the wind and large beetles.

The fat sand rat is a specialized herbivore, feeding exclusively on a single species (*Salsola* sp.). Since the fat sand rat has no interest in baits and its burrows are found only where there is an abundance of *Salsola* sp., captures of this species occurred only when the animal walked across the trap treadle. This species has numerous openings to a single burrow system. At several burrow systems, we plugged all but one opening and set numerous traps around that opening. These efforts resulted in only one capture. We next tried an activity index measurement for the fat sand rat. We selected and marked 25 active burrow systems on the border of Plot 8 in the area we had previously trapped. We plugged all openings in each of these systems with soil and rocks and examined them 24 hours later. This activity index method yielded encouraging results: 62.5 percent of the closed burrow systems had been opened by rats 24 hours later. The 24-hour activity data are presented in Table 5.

Plot Reconnaissance

Low capture of small mammals in the designated areas of experimental plots was apparently due to the clustered distribution of the fat sand rat and the jird. We visually estimated the abundance and distribution of those species and concluded that their numbers in the designated sampling areas on plots, with the exception of Plot 7 and possibly 8, were insufficient to obtain meaningful pre- and posttreatment indices of abundance. To obtain useful indices of small mammal abundance, the small mammal sampling areas on each plot should be enlarged. Home ranges and daily movement of these species, except during dispersal of young animals, are very limited. Consequently, it would be beneficial if the sampling areas were expanded to within about 50 m of the plot boundaries. If this is done, small mammal indices could be obtained on all plots except those in Block B. In Block B, Plots 4 and 5 contained the least suitable habitat for the fat sand rat and the jird. A few fat sand rats and burrows were seen on Plot 6. However, Plot 6 contains a unique habitat on the north end. This area consists of a slight depression about 150 x 30 m with noticeably taller vegetation. Although we did not trap in this area, it appeared promising for shrews and Barbary mice.

Recommendations

1. The fat sand rat, followed by the jird, appears to be the most abundant small mammal on the plots. Both are diurnal species living in common, but limited habitats. Both species build burrow systems with several opening, and it is difficult to distinguish between their burrows. However, if the burrow is in or near the *Salsola* sp., it is most probably that of the fat sand rat. These two species will probably be the best indicator species of small mammal treatment effects on the plots. If trapping is used to assess effects, the mammal sampling areas within each plot should be enlarged to within 50 m of the plot boundaries.

2. Small mammal sampling pre- and posttreatment should consist of one trap line 200 m long with 20 stations. Each station should have 3 rat traps and 2 mouse traps baited with dried dates. Because the wind tends to spring the mouse traps, it may be useful to dig a small trench about 4 cm deep x 25 cm long and place each mouse trap in the trench at each station. Traps should be checked and rebaited as needed each morning and evening for 3 consecutive days. The number of traps sprung or missing should be recorded each morning and evening to determine the number of available traps for calculating the relative rodent densities.

   Trapping of fat sand rats may be enhanced by increasing the rat trap trigger size. This could easily be done with corrugated cardboard, but the larger trigger will make the trap more subject to being sprung by the wind. The Moroccan scientists say they have better trapping success with these species by plugging all but one burrow opening and using several French-made live traps. Based on their description of this trap, it is a Firobind live trap (43 Avenue Clemencian, 25000 Besancon, France) in the next larger model than the 28-cm Ratiere. Another method that may enhance trapping would be to plug all but one burrow opening and construct drift fences to the rat traps.

3. The difficulty in trapping and capturing the jirds and the fat sand rat suggests that activity measurements may provide a better indicator of abundance. Since the jird is also diurnal and frequently lives in the same habitat as the fat sand rat, activity measurements should work equally well with the jird. However, in using activity measurements, it would be difficult to distinguish between these two species. In late January and early February, activity may well be reduced in both species because of the colder weather. However, any reduced activity would be reflected equally in trapping data or activity measurement data. A 48-hour closed/open hole activity measurement should be used to estimate the abundance of these species pre- and posttreatment. On each plot, this should consist of two groups of 25 active burrow systems in which openings are closed and then inspected 48 hours later for open holes.

Bird Surveys (Michael L. Avery)

Activities of the avian nontarget hazard assessment team focused on (1) familiarization with the location and layout of the study plots, (2) recognition and identification of the bird species present on the study plots, and (3) conducting bird counts on the study plots using the method that will be employed during research in January-February 1992.

We used a fixed-radius point count method patterned after Hutto et al. (1986, Auk 103:593-602). After arriving at a count station, the observer waits for 1 minute, then records all birds observed during the next 5 minutes. Birds are recorded as either within 50 m of the observer or greater than 50 m from the observer. After the 5-minute count period, the observer walks to the next station. All birds seen while walking between stations are recorded in a separate column of the data sheet.

Each of the Moroccan scientists was assigned responsibility for conducting bird counts on 3 of the study plots. Mr. Aloui was assigned Plots 1, 2, and 3 (Block A); Mr. El Addami was assigned Plots 4, 5, and 6 (Block B); and Mr. El Hani (who could not attend this session due to a special assignment) was assigned Plot 7, 8, and 9 (Block C). These individuals will conduct the counts on their plots during the pre- and postspray periods of research.

We conducted the bird counts each day between 0800 and 1200. We then reviewed the day's results, discussed any new species, and talked about any problems that surfaced relating to bird identification or the count technique itself. We returned to the field most afternoons, principally to collect data on the vegetation of the study sites. In Plots 1, 2, 3, and 6, we estimated plant cover by species in each of three 1- x 1-m quadrants located near each of the 15 bird count points. Lack of time precluded vegetation sampling in the remaining plots. This time in the field also afforded us opportunities to improve bird identification skills.

Altogether, 33 bird species were recorded on the study areas (Table 6). By far, the most common species was the Thekla lark. Our identification of the lark as *Galerida theklae* instead of the nearly identical crested lark (*G. cristata*) was based on in-hand examination of 9 mist-netted birds. Further confirmation of the identify of the larks throughout the study area is desirable.

Other common species included Moussier's redstart (*Phoenicurus moussieri*) and two species of wheatears (*Oenanthe moesta* and *O. deserti*). The redstart and the wheatears are ground-foraging insectivores. Together with the larks, they should be good study species because they are abundant (we should be able to collect enough for food habit and cholinesterase studies) and conspicuous (we should be able to obtain sufficient observations to document behavioral changes due to insecticide application).

Two additional species may also merit consideration for special attention. The little owl (*Athene noctua*) was much more common on the study sites than we anticipated. This should be a prime candidate for telemetry study. Also, it might be worthwhile to determine population changes by censusing

at dusk with tape recorded calls. We have no information on the availability of little owl recordings. The great gray shrike (*Lanius excubitor*) was not common, but was regularly seen atop taller vegetation along gullies and dry creek beds. Reportedly, shrikes are very sensitive to insecticide applications, so pre- and postspray count data on this species might prove particularly useful.

Table 1. Participants in the October 1991 evaluation of methods on the study area.

Scientists	Affiliation
MOROCCAN	
Birds	
Aloui, A.	Plant Protection Department, Rabat
El Addami, L.	Provincial Agriculture Office, Guelmim
Entomology	
Akchati, M.	Bureau of Pesticides, Rabat
Baou, A.	Plant Protection Department, Rabat
Benchra, M.	Bureau of Pesticides, Rabat
Daia, M.	Plant Protection Department, Rabat
Dliou, A.	Provincial Agricultural Office, Aït Melloúl
El Bakkouri, A.	Plant Protection Department, Rabat
El Fayq, A.	Regional Agricultural Inspector, Laayoune
Ghaout, S	Plant Protection Department, Rabat
Mouhim, A.	Locust Control Center, Aït Melloúl
Sahil, S.	Provincial Agricultural Office, Aït Melloúl
Mammalogy	
Arroub, H.	Plant Protection Department, Rabat
Cherhbili, M.	Provincial Agricultural Office, Tiznit
Id Messaoud, B.	National Rodent Laboratory, Marrakech
Ouzaouit, A.	National Rodent Laboratory, Marrakech
Radiotelemetry	
Alhillali, O.	Locust Control Center, Aït Melloúl
Ramzi, M.	Provincial Agricultural Office, Aït Melloúl
AMERICAN	
Avery, M.	Denver Wildlife Research Center
Keith, J.	Denver Wildlife Research Center
LaVoie, K.	Denver Wildlife Research Center
Matteson, P.	Iowa State University, Ames
McConnell, J.	Denver Wildlife Research Center

Table 2. Insect groups covered in skills development training.

Orders (for practice with keys to orders, and for orientation of non-entomologists)

Coleoptera
Diptera
Hymenoptera
Neuroptera
Hemiptera
Dermaptera
Odonata
Orthoptera
Mantodea
Lepidoptera
Trichoptera

Families* (for practice with keys to families)

Order Neuroptera	Chrysopidae
Order Hemiptera	Nabidae Reduviidae Phymatidae Lygaeidae Pentatomidae
Order Coleoptera	Carabidae Staphylinidae Trogidae Coccinellidae Tenebrionidae Meloidae, including genera *Mylabris* and *Epicauta* Cleridae, including genus *Trichodes*--briefing only (Scarabaeidae) (Chrysomelidae)
Order Diptera	Asilidae Nemestrinidae--briefing and handout only Bombyliidae Syrphidae Calliphoridae Sarcophagidae Tachinidae (Tabanidae) (Chironomidae)

Table 2. (Continued)

Families (Continued)	
Order Hymenoptera	Ichneumonidae
	Braconidae, including Aphidiinae
	Scelionidae
	Sphecidae, including tribe Sphecini
	Vespidae
	Formicidae
	Trichogrammatidae--display only
	(Symphyta)
	(Pompilidae)
	(Perilampidae)
	(Chalcididae)
	Bees (superfamily Apoidae)
	Apidae
	Andrenidae--briefing only
	Colletidae
	Oxaeidae--briefing only
	Halictidae
	Melittidae
	Megachilidae
	Anthophoridae

* Families in parenthesis are not usually monitored in ecotoxicological studies, but specimens were keyed so that participants would be familiar with major divisions within orders or because the specimens closely resembled or are closely related to groups of interest.

Table 3. Wild mammals seen or caught on the study area during October 1991.

Order	Common name	Scientific name	Captured (c) or sighted (s)
Insectivora	Shrew	*Crocidura* sp.	c
	Elephant shrew	*Elephantulus rozeti*	c
	Algerian hedgehog	*Erinaceus algirus*	c
Lagomorpha	Brown hare	*Lepus capensis*	s
Rodentia	Barbary ground squirrel	*Atlantoxerus getulus*	s
	Garden dormouse	*Eliomys quercinus*	c
	North African gerbil	*Gerbillus campestris*	c
	Shaw's jird	*Meriones shawi*	c
	Fat sand rat	*Psammomys obesus*	c
	Barbary striped mouse	*Lemniscomys barbarus*	c
	Lesser Egyptian jerboa	*Jaculus jaculus*	s
Carnivora	Jackal	*Canis aureus*	s
	Red fox	*Vulpes vulpes*	s
	African wild cat	*Felis libyca*	s
Artiodactyla	Wild boar	*Sus scrofa*	s
	Gazelle	*Gazella* sp.	s

Table 4. Small mammal trapping data.

Plot No.	Available traps*	Captures	Sex
1	rat-----14	1 *Meriones shawi*	male
	mouse---50		
2	rat----120		
	mouse--240	1 *Crocidura* sp.**	?
7	rat----207	2 *Meriones shawi*	males
	mouse---72	2 *Lemniscomys barbarus*	male and female
	live-----4	1 *Psammomys obesus*	female
8	rat----210	3 *Meriones shawi*	males
		1 *Elephantulus rozeti*	male
	mouse----0		

* Available traps are those present that were not sprung each morning.

** Specimens eaten by ants; sex and species undetermined.

Table 5. Activity index data (24-hour period) for *Psammomys obesus*.

Burrow system No.	Openings closed	Openings reopened
1	6	2
2	2	0
3	4	0
4	4	0
5	10	4
6	7	1
7	7	0
8	12	2
9	9	1
10	5	1
11	3	marker missing
12	12	3
13	2	0
14	8	3
15	3	2
16	4	0
17	4	0
18	5	1
19	7	0
20	9	3
21	4	3
22	12	2
23	7	1
24	10	2
25	3	0

Burrows systems closed - 24
Burrows systems opened - 15

Activity index = 62.5%

Table 6. Bird species observed in the study area, October 1991.

Scientific name	English name	French name
Milvus migrans	Black kite	Milan noir
Buteo rufinus	Long-legged buzzard	Buse feroce
Falco tinnunculus	Kestrel	Faucon crécerelle
F. biarmicus	Lanner falcon	Faucon lanier
Alectoris barbara	Barbary partridge	Perdrix gamba
Burhinus oedicnemus	Stone curlew	Oedicnème criard
Cursorius cursor	Cream-colored courser	Courvite isabelle
Gallinago gallinago	Snipe	Bécassine desmarais
Pterocles orientalis	Black-bellied sandgrouse	Ganga unibande
Athene noctua	Little owl	Chouette chevéche
Caprimulgus ruficollis	Red-necked nightjar	Engoulevent à collier roux
Jynx torquilla	Wryneck	Torcol fourmilier
Galerida theklae	Thekla lark	Chochevis de Thekla
Hirundo rustica	Barn swallow	Hirondelle de chemiénée
Anthus campestris	Tawny pipit	Pipit rousesseline
Motacilla flava	Yellow wagtail	Bergeronnette flavéole
M. alba	White wagtail	Bergeronnette grise
Phoenicurus moussieri	Moussier's redstart	Rougequeue de Moussier
Saxicola rubetra	Whinchat	Traquet tarier
S. torquata	Stonechat	Traquet pâtre
Oenanthe deserti	Desert wheatear	Traquet du désert
O. moesta	Red-rumped wheatear	
Scotocerca inquieta	Scrub warbler	
Sylvia deserticola	Tristram's warbler	Fauvette du désert
S. melanocephala	Sardinian warbler	Fauvette melanocephale
S. conspicillata	Spectacled warbler	Fauvette à lunettes
S. cantillans	Subalpine warbler	Fauvette passerinette
Phylloscopus collybita	Chiffchaff	Pouillot véloce
P. trochilus	Willow warbler	Pouillot fitis
Muscicapa striata	Spotted flycatcher	Gobemouche gris
Tchagra senegala	Black-headed bush-shrike	Tchagra à tête noire
Lanius excubitor	Great gray shrike	Pie-grièche grise
Pica pica	Magpie	Pie bavarde

Figure 1

Morocco Training and Study Areas

Figure 2

MOROCCO STUDY AREA

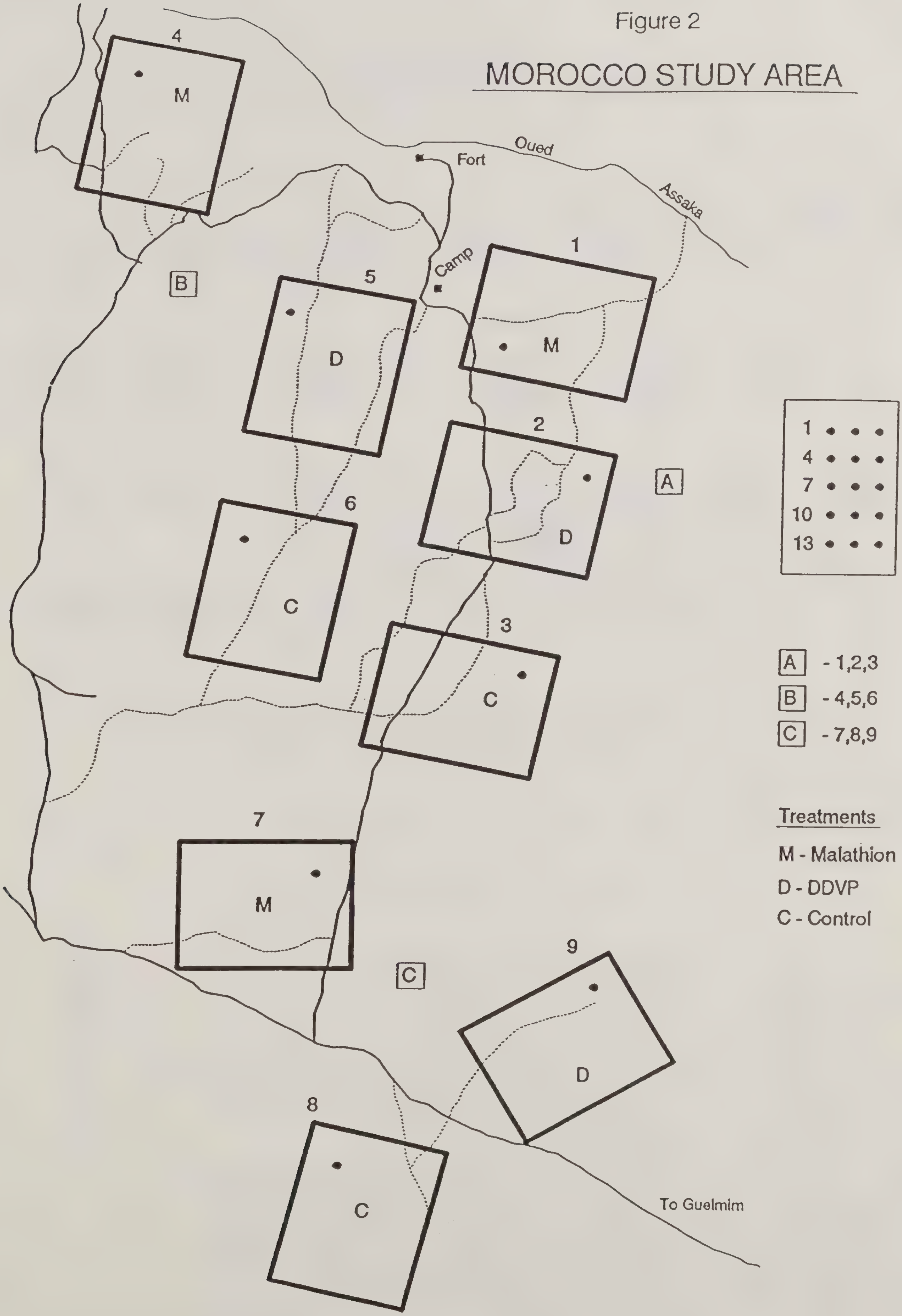


Figure 5

BIRD SAMPLING SCHEME

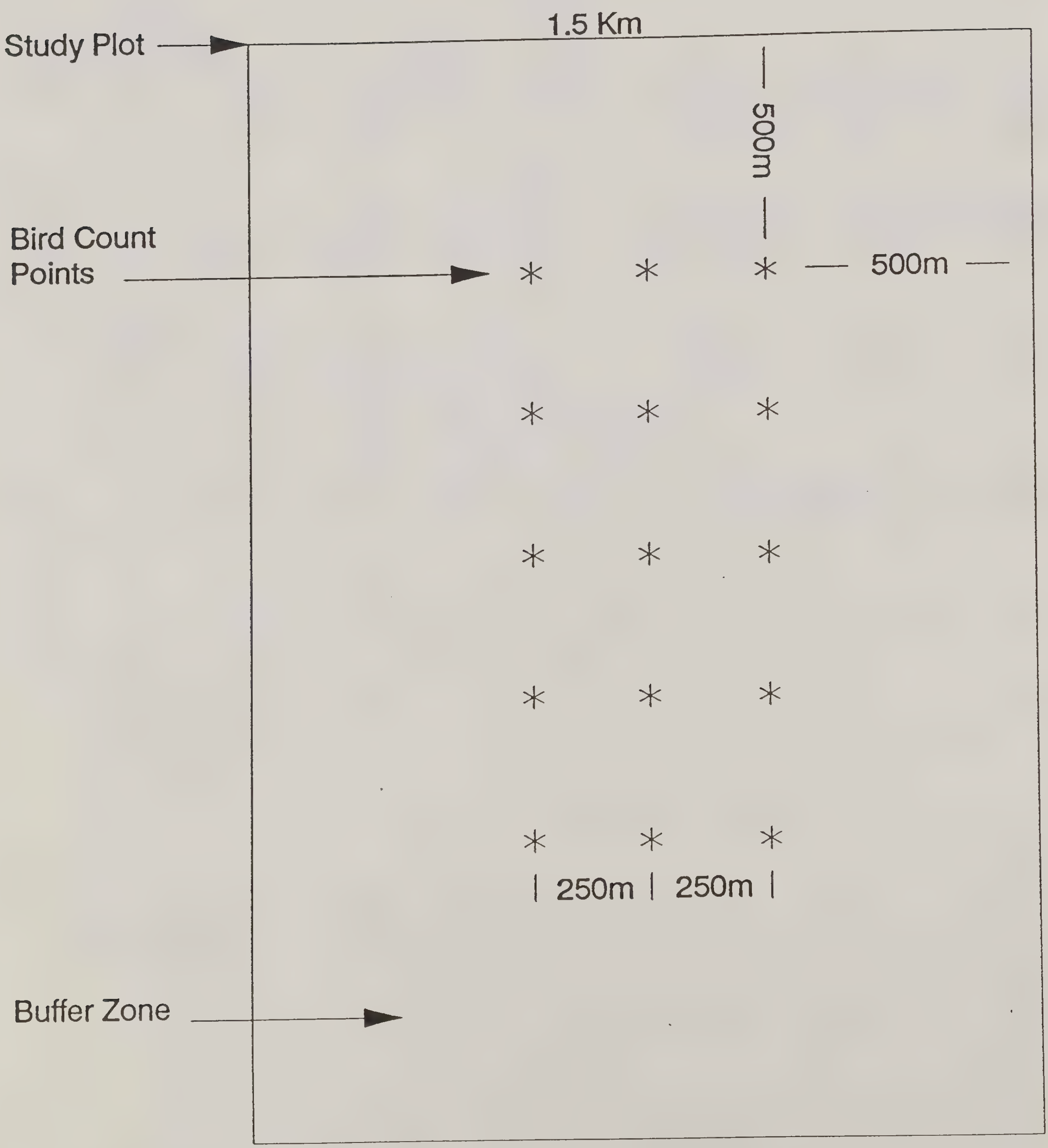
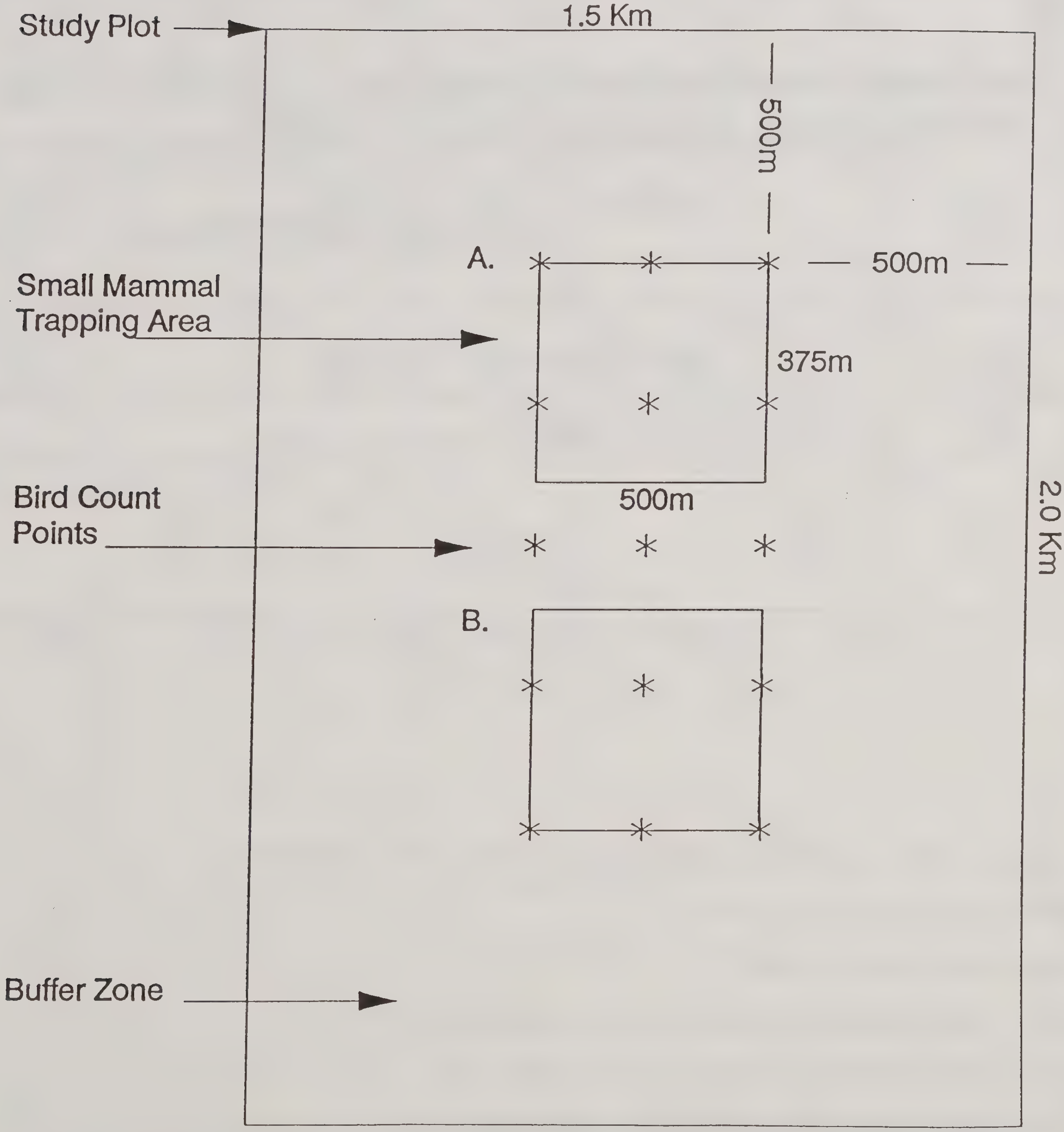


Figure 6

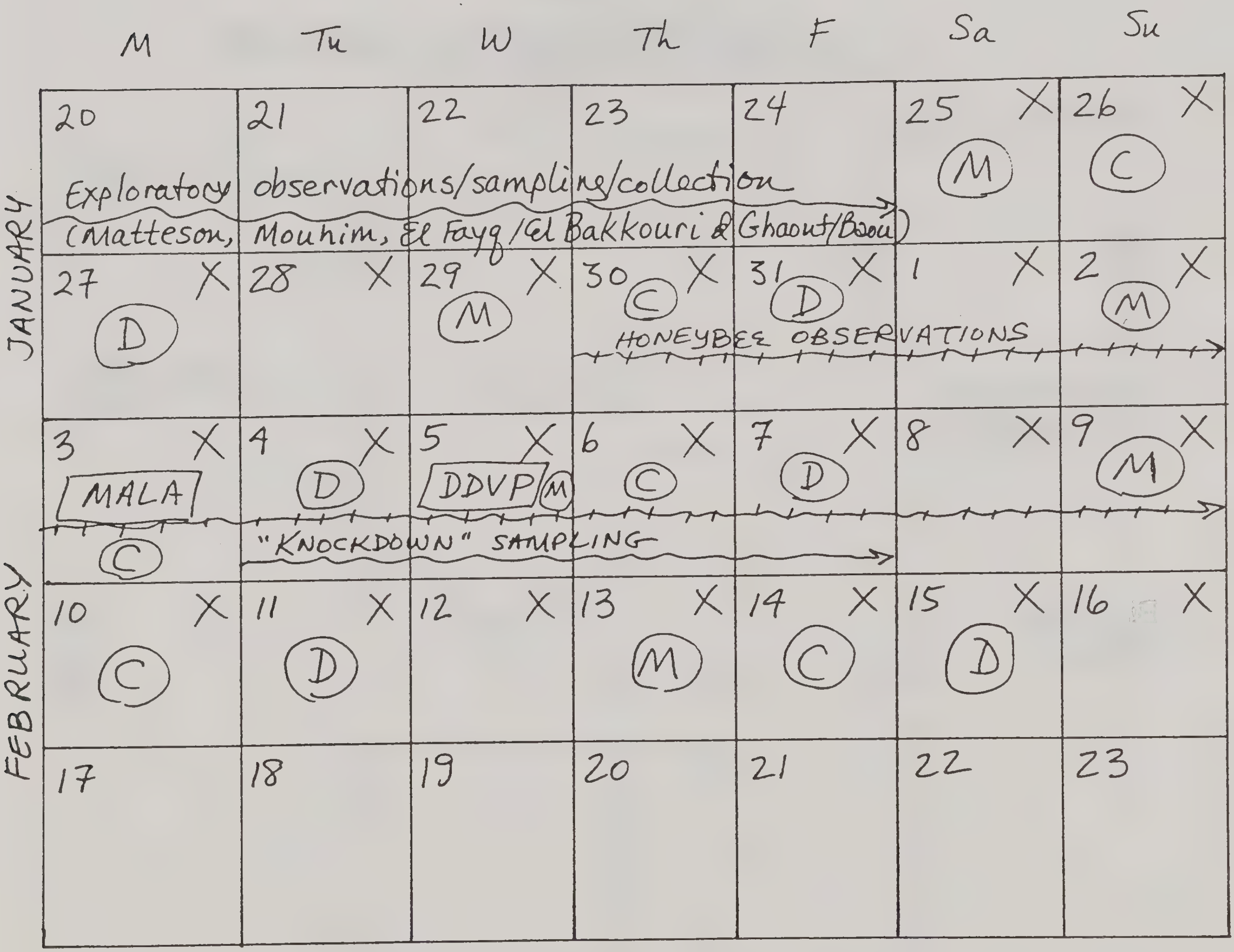
MAMMAL SAMPLING SCHEME



A. Pre-treatment rodent sampling unit
B. Post-treatment rodent sampling unit

Figure 7

Entomology activity plan. Field experiment on nontarget effects of locust insecticide applications. Bou Jerif. Morocco. Jan/Feb 1992.



X = Days field sample taken (all teams)

MALA = Application of malathion

DDVP = Application of DDVP

(M) = insect population sampling on malathion plots

(C) = insect population sampling on control plots

(D) = insect population sampling on DDVP plots

DRAFT

CONSULTANT'S REPORT*

RECOMMENDATIONS ON THE NEED AND USE OF STATISTICAL SURVEYS FOR EVALUATING THE IMPACTS OF BIRD DAMAGE TO CROPS IN URUGUAY AND ARGENTINA

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ITINERARY

DATE	LOCATION	ACTIVITY
Oct. 15	"	Field trip to rice growing area of Entre Rios
Oct. 16	"	Worked at INTA
Oct. 17	Parana to Buenos Aires, Argentina	Meeting with Diana Guillen, Ministry of Agriculture
Oct. 18	Buenos Aires	Meeting with Eduardo Rodriguez Vergez, UNDP/FAO
Oct. 19	"	Work on survey design; Summary meeting with Zaccaganini, Rodriguez, Bucher and Arregoces
Oct. 20	"	Worked on report
Oct. 21	"	Worked on report; Departed for Clemson,SC
Oct. 22	Buenos Aires to Clemson SC	Travel

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OBJECTIVES

This report contains an evaluation of the need for reliable information about the distribution and magnitude of economic losses caused by several species of birds to agricultural crops in the binational area of Uruguay and Argentina, as defined by FAO Project TCP/RLA/8965(a) "Integrated Control of Bird Pests". Secondly, the report contains recommendations for statistically reliable sampling designs that can be used in the context of both short-term and long-term research and extension programs that may be developed with the goal of creating integrated control strategies for birds in this region.

The conclusions and recommendations in this report are made with the aid of information obtained from visits to field sites in the region, discussions with other expert consultants, government officials and national counterparts, and use of crop and damage statistics obtained from these and other published sources. In particular, I want to thank Ethel Rodriguez, Maria Elena Zaccagnini, Enrique Bucher and Oscar Arregoces for their assistance during my consultancy.

OVERVIEW

The provinces of Buenos Aires, Cordova, Entre Rios and Santa Fe in Argentina, and roughly the western one-third of Uruguay in the Rio de la Plata Region, comprise the binational region of more than 500,000 km^2. Climate and dominant vegetative communities vary considerably, ranging from semi-arid thorn-scrub regions in the west, to "humid Pampas" near the Parana and Uruguay Rivers. Land use is dominated by livestock and crop production and the landscape is somewhat typical of agroecosystems, i.e., interspersion

of pasture, cultivated land, woodlots and shrub communities. However, predominate cropping practices and livestock operations vary on a relatively small scale so that large monocultural regions are not typical. Sheep, dairy and beef cattle are raised and field crops include winter wheat and barley and summer crops of sunflower, soybean, grain sorghum and rice.

The bird species that attack the major agricultural crops and purportedly cause significant economic losses have been well-documented and described (Bucher and Bedeno 1976, Bullard 1991, DeGrazio and Besser 1975, DeGrazio 1985). The species of most concern are the Monk Parakeet (Myiopsitta monachus), Eared Dove (Zenaida auriculata), Spot-winged Pigeon (Columba maculosa) and the Picazuro Pigeon (Columba picazuro). The parakeet is a gregarious bird that builds huge communal nests in groves of large trees, primarily eucalyptus. It has a clustered distribution throughout the region and generally averages less than 1 adult/hectare throughout its range (Bucher 1985). The Eared Dove is the most numerous bird in the region. Several million individuals can gather in huge roosting and breeding colonies located in both thorn-scrub and forested habitats. Although an accurate count does not exist, there are probably several dozen of these colonies in the binational region. Less is known about the population dynamics of the two pigeon species, although it is certain that they do not achieve populations nearly as large as the dove (Bucher 1985). These pigeons also display some degree of gregariousness and can be found in large nesting colonies (Bullard 1991).

EXISTING CROP LOSS INFORMATION

Past Surveys

Although many investigators have devoted effort to crop damage surveys and techniques during the last fifteen years, no statistically reliable economic loss information exists for any crop on a regional scale. Calvi et al (1976) estimated losses of $250,000 in Uruguayan wheat in 1974. However, this estimate appears to have been based upon the opinion of government officials and not on empirical assessment data.

The most frequently quoted statistic is $6 million in crop losses in Uruguay and $36 million in Argentina (FAO 1980). However, I could find no information about the source of information that was used to produce this estimate; it almost surely was not the result of an empirical field or questionnaire survey. DeGrazio (1985) investigated grain sorghum and sunflower damage assessment techniques in Uruguay and suggested a statistical design for a national field survey of sorghum. His recommendation to conduct this survey in 1986 was not followed. Some statistically designed surveys have been conducted in grain sorghum (E. Rodriguez, unpublished data) and sunflower (M. Zaccagnini, unpublished data), but on a very local scale. A more common and less expensive alternative to a field survey is a mail questionnaire survey of farmers. This tool has been used by at least one provincial government agency in Argentina (Entre Rios in 1987) and perhaps other similar surveys have been conducted elsewhere in Argentina and Uruguay. The reliability of such surveys is, however, unknown since the estimates are based on farmers opinions about their crop losses. In addition, there is the problem of response bias in mail surveys, i.e., is the

sample of farmers that respond to the survey a representative sample of the entire population of farmers, or is there a positive correlation between the probability of response and the amount of perceived loss?

Expert Opinion

The binational region is very large in size and, as previously mentioned, a large variety of cultivated crops are grown within its boundaries. Although there are large areas in which one or two crops dominate, there is nonetheless considerable geographic variation in crop patterns. There is also of annual variation in crop patterns because farmers tend to postpone decisions about allocation of their land to various crop types until prevailing economic market conditions, rainfall patterns and other indicators are known to them. Further complicating the situation is the fact that several bird species are involved in crop damage and that much remains unknown about their population size, distribution, migration patterns and trends over time. One notable exception is the work of Bucher (1990), who documented the correlation between trends in dove populations and amount of sorghum cultivation in the Argentine province of Cordova.

Given the dynamics of both cropping patterns and bird populations, it is not surprising that there is a diversity of opinion within and among scientists and government administrators at both the local and national level about which crops are experiencing the most serious economic losses. Moreover, these opinions are dynamic and are dependent on the creation of new data, changes in available control methods and political pressures felt by administrators that have responsibility for assisting farmers. For example, many specialists that I interviewed in Argentina believed that pigeon damage to emergent

soybean seedlings was one of the two or three most important problems. However, Fiedler (1990) listed soybeans as 6th in order of importance and Jaeger (1991) did not make any mention of soybean damage by pigeons. In Uruguay, many specialists believe that dove damage in mature barley is currently a more significant problem than is damage in sorghum, which has in the past been considered the most serious problem in Uruguay (DeGrazio 1985).

Conclusions

Fragments of information about crop damage by birds in the binational area are available from a variety of sources: (1) previous field surveys conducted on a local scale, (2) mail questionnaires, (3) knowledge of the food habits, bioenergetics and habitat requirements of the bird species involved and (4) opinions of scientists, agricultural specialists, and private sector individuals involved in the agriculture industry, e.g., commercial fertilizer and pesticide companies. Individually and collectively, these sources generally support the contention that economically significant losses could be occurring in a few predominant crops in both Uruguay and Argentina. As a hypothetical example, consider the potential loss caused by doves and parakeets in mature sunflower crops. Based on information obtained from Ing. Agr. Mabel G. K. de Rodriguez, an economist working with INTA in Parana, Argentina, one hectare of sunflower produced in Entre Rios in 1991 was worth about $250. If we use a reasonable guess of 2 percent as an average loss over the entire binational region, then farmers lose an average of $5/ha and total loss would be $7.5 million, based on an estimate of 1.4 million ha of cultivated sunflower. The problem with this exercise, however, is that it is based on a set of assumptions and not on

objective, statistically reliable data that has been collected in a way that would justify such extrapolations. In fact, no such data set has ever been collected for any crop in Argentina or Uruguay. Therefore, my conclusion is that the current database does not support any objective, statistically reliable statements about the distribution and magnitude of crop losses in the binational area.

FUTURE NEED FOR ADDITIONAL INFORMATION

Evaluation

Although the existing database on crop losses is fragmented and of variable quality, a decision to expend future resources on the gathering of additional information should be based upon an assessment of the utility of such information within the context of an enhanced effort to produce cost-effective and environmentally responsible management strategies for birds. My subsequent recommendations for damage surveys are based on the following considerations:

(1) Although comprehensive, reliable figures are not available, it is reasonable to assert that tens of millions of dollars are currently being spent on bird control efforts by farmers and, indirectly, by provincial, departmental and national government agencies that provide assistance to farmers through extension activities, etc. For example, it has been estimated that farmers in Entre Rios expend an average of $18/ha on toxic baits to kill doves and pigeons in sunflower crops (M. G. R. de Rodriguez, unpublished data). In 1990, 60,500 ha were estimated to have been planted to sunflower in Entre Rios, which means that more than $1 million were spent by farmers in this province to try to reduce losses in

a single crop in a single year. However, no information is available that would allow an objective assessment of the cost-effectiveness of this practice, or of any other bird control technique currently in use. Such an assessment requires objective, reliable information on the distribution and magnitude of economic loss, as well as concurrent evaluation of the effectiveness of proposed control techniques.

(2) It has been suggested by several experts (Bucher, 1985; Fiedler, 1990; Jaeger, 1991; Keith, 1991) that the practice of spreading poison baits for doves and pigeons and applying poison formulations to parakeet nest openings may be resulting in negative environmental impacts on nontarget bird species as well as significant contaminant levels in soil and water. Although there are current efforts underway to replace the toxicants that are currently used with less environmentally offensive toxicants, the practice of widespread poisoning of birds appears to be a deeply ingrained practice within the agricultural industry (Arregoees, pers. comm.). Moreover, governmental regulations that govern the indiscriminant or illegal use of these pesticides are not actively enforced (E. Rodriguez, M. E. Zaccagnini; pers. comm.). In view of increasing national and global concerns about the effects of toxic pesticides on the integrity of the environment, and a corresponding concern for the wise management of our natural resources, it would seem that any large scale program of research and/or management should be supported by defendable statistics on the economic significance of the bird problem.

(3) One aspect of the Terms of Reference of my consultancy (Appendix I) is to provide assistance in planning a long term (5 year) project devoted to improving the effectiveness of management strategies for reducing crop losses. I believe such a project

must necessarily focus on a very few bird/crop interactions. Project resources will always be limited and should be used to support well designed and executed programs that involve only the most serious economic problems. Given the large variation in cropping practices, bird species and land use patterns found in the binational region, several different approaches to research prioritization could be used to categorize or rank the problems. For example, one could attempt to rank the bird species in order of importance, depending on the level of damage they cause to all agricultural crops collectively. Or one could rank crops according to the percent or dollar loss caused by the 4 species of primary concern. Finally, economic losses could be summarized geographically, i.e., relatively large areas of similar land and crop use patterns could be identified and the extent of the losses in the crops grown in these regions used to category areas of most importance. Whichever system or combination of systems is used, it is obvious that defendable crop loss statistics will be essential to development of such a system that should be used to define the objectives of future long term programs.

Recommendations

Based on my assessment of currently available information, the likelihood of continued, indiscriminant killing of birds in the absence of cost effectiveness data, and the need to develop a long term research and extension program, my first recommendation is that a survey of crop losses be conducted in the entire binational region in 1992. The most important objectives of this survey will be to produce a general, yet comprehensize description of the distribution and magnitude of losses so that objective, statistically reliable data are available to assist in the assessment of the value of current bird management

practices and governmental policies, and to provide information that should be critical to the planning of a long term project for development of integrated bird control strategies. Statistical design of this survey is discussed in the following section.

With respect to the question of the role that damage surveys should play in the long term project, my recommendation is as follows. Jaeger (1991) has recommended that such a project should involve a systematic program of research in two large (180-km^2) sites. I endorse this concept; ideally, the choice of the study areas and the control strategies to be investigated should not be specified until the 1992-3 damage survey has been conducted. However, I realize that political and funding considerations may make such a time schedule unacceptable. Whatever the timing and initiation of the program, intensive monitoring of damage distribution and amount in each of the study areas should be an essential component of the project, in order to evaluate the cost-effectiveness of the integrated control strategies that are being tested. In this report I will not make any specific recommendations on an appropriate survey design for such a purpose, since such a design will need to be developed within the context of the specific objectives and available resources of the project. However, the task of designing a survey would be greatly facilitated by the availability of satellite imagery of the study sites. Use of this technology would not only provide critical information on land-use patterns, but could be used to produce complete lists of cultivated lands. Given the availability of such lists, relatively straightforward stratified or multiple stage cluster sampling techniques (Cochran 1977) could be used to select samples of fields for periodic monitoring of damage. Data from the 1992 survey, if available, could be analyzed to provide valuable estimates of variance in loss

estimates, so that proper sample size and cost analyses could be performed.

DESIGN OF 1992-3 SURVEY

Introduction

There are essentially 3 different techniques that could be used to produce estimates of losses to birds (Otis 1989): (1) mail questionnaire or direct interview surveys of farmers or agricultural specialists, (2) direct field surveys of crops, (3) bioenergetics models. I did not consider the last approach due to a lack of sufficient knowledge about the energetics and dynamics of the species involved. Mail and personal interview surveys are attractive because they are cheaper then field surveys and because additional social or human dimension information can be obtained. However, the accuracy of the results depends completely on the respondents' ability to accurately assess their economic loss. In the absence of any calibration data that could be used to assess this accuracy, I believe it would be unwise to rely strictly on a mail or questionnaire survey to produce a statistically defendable assessment of the bird problem. Direct field surveys should provide the most accurate and reliable information but it is the most expensive to collect.

In addition to choice of a survey technique, the second major question is to decide which crop or crops should be surveyed. For a fixed amount of effort, surveying several crops can dilute the effort to the point that relatively poor information is obtained for each of the crops. Conversely, due to the large number of combinations of growing seasons, crop types and bird species (Table 1), surveying only a single crop in the entire binational region will provide a very incomplete understanding of the situation.

Table 1. Summary of Bird Pest Problems in Uruguay (from De Grazio, 1985).

Order of importance	Crop	Acreage (ha) 1983	Crop stage	Species causing damage	Time period	Major damage areas
1a	Sorghum	58,998	Mature	Blackbirds Doves** Parakeets	Mar-May	Rio Uruguay*
			Emergent	Blackbirds Doves	Oct-Nov	
1b	Sunflower	40,661	Mature	Parakeets Doves	Mar-May	Rio Uruguay
			Emergent	Doves	Oct-Nov	
1c	Barley	61,458	Mature	Blackbirds Doves	Nov-Dec	Rio Uruguay
2a	Corn	37,855	Mature	Parakeets Doves	Mar-Apr	Rio Uruguay
			Emergent	Doves	Oct-Nov	
2b	Wheat	270,216	Mature Emergent	Doves Doves	Nov-Jan Jun-Aug	Rio Uruguay
2c	Rice	67,024	Mature Emergent	Blackbirds Ducks	Feb-Mar Oct-Nov	Departmento Treinta y Tres
3	Fruits	-	Mature Bud stage	Parakeets	Dec-Apr	Departamentos Canelones and San Jose
4a	Soybeans	11,919	Emergent	Doves	Oct-Dec	Dispersed
4b	Peanuts	-	Mature	Blackbirds Parakeets Doves	Mar-May	Rio Uruguay and Tacuarembo
			Emergent	Blackbirds Doves	Oct-Dec	

* Rio Uruguay includes: Departmentos Salto, Paysandu, Rio Negro, Soriano, and Colonia.
** Doves include: doves (*Zenaida auriculata*) and/or pigeons (*Columba* spp.)

Table 1 (cont'd). Summary of Bird Problems in Argentina (from Fiedler, 1990).

Order of importance	Crop	Crop stage	Species causing damage	Time period*	Major damage areas*
1	Sunflower	Mature	Doves Parakeets Pigeons	Aug-Sep	Buenos Aires, Cordoba, Entre Rios, Sante Fe
		Emergent	Pigeons	Sep-Nov	Santa Fe, Entre Rios, Cordoba, Buenos Aires
2	Sorghum	Maturing	Doves Parakeets	Feb-Mar	Cordoba, Entree Rios, Santa Fe
		Emergent	Doves Pigeons	Oct-Nov	Cordoba, Entre Rios, Sante Fe
3	Corn	Mature	Parakeets	Jan-Mar	Buenos Aires, Cordoba, Santa Fe, Entre Rios
4	Wheat	Emergent	*Chloephaga* spp. Parakeets	Aug-Sep	Buenos Aires
		Milk stage	Finches	Oct	Entre Rios
		Mature	Doves Parakeets	Nov	Buenos Aires Cordoba, Entre Rios, Santa Fe
5	Fruit trees (peaches)	Mature	Parakeets	Nov-Dec	Buenos Aires,
6	Soybean	Emergent	Pigeons and Doves	Nov-Dec	Cordoba, Entre Rios and Santa Fe
7	Pasture	Emergent	*Chloephaga* spp. and Pigeons	Mar-Apr	Buenos Aires Entre Rios
8	Forest (*Eucalyptus* and *Pinus*)	Seedling	Parakeets	--	Sante Fe, Entre Rios
9	Structures	Electric poles	Parakeets		Cordoba, Entre Rios, and Santa Fe, Buenos Aires
		Airports	Doves	Jan-Dec	Buenos Aires Cordoba, Entre Rios, Santa Fe
			Nighthawks	Jan-Feb	Entre Rios

* Damage in the Buenos Aires Province is generally at the later part of the given range compared to the other more northern provinces.

Summary of Recommended Survey Design

In this section I will describe the essential features of the suggested survey. Statistical formulas and derivations associated with the design and analysis of the survey are contained in Appendices.

The survey should be conducted in both a winter and summer growing season. In each season, one crop type believed to be most vulnerable to birds will be surveyed. Because of the geographical differences in habitats, bird species and cultivation patterns in the binational region, the surveyed crop may be different among Uruguay and each of the 4 provinces of Argentina. Based on the input received from specialists during my consultancy, Table 2 shows the recommended crops and timing of the survey. The choice of specific crop types can be revised at a later date if appropriate. The important point is that both newly planted (sprouting) and mature crops are surveyed over the course of the primary growing season in each area.

Table 2. Recommended crops to be surveyed for bird damage in the binational region during October, 1992 - March, 1993.

Area	Crop	Time of Survey
Uruguay	Mature barley	November, 1992
Uruguay	Mature sunflower	March, 1993
Entre Rios	Sprouting sunflower	October, 1992
Entre Rios	Mature sunflower	February, 1993
Sante Fe	Sprouting soybean and sunflower	October, 1992
Sante Fe	Mature sunflower	February, 1993
Cordova	Sprouting soybean and sunflower	October, 1992
Cordova	Mature grain sorghum	March, 1993
Buenos Aires	Sprouting sunflower	November, 1992
Buenos Aires	Mature sunflower	March, 1993

The initial survey I developed involves a combination of farmer interviews and field assessments. The design is commonly referred to as double sampling (Cochran 1977) and it attempts to both maximize cost effectiveness by relying in part on cheaper interview surveys and to assure that opinion data are adjusted for any bias by calibrating the opinion data with assessment data. The outline of this survey follows; details are provided in Appendix 2.

(1) In each of the 5 major regions in Table 2, farmer cooperatives are used as the primary sampling unit. I assume that all of the farmers in a region can be classified by membership in a single cooperative. If a farmer belongs to more than one cooperative, he can be arbitrarily assigned to a single one for sampling purposes.

(2) A sample of cooperatives is chosen with replacement and with probability proportional to the number of farmers, and 10 farmers are randomly selected from the membership list of each of the cooperatives.

(3) Each of the selected farmers is personally interviewed to collect information about the location and size of each of their cultivated fields of the appropriate crop type. They are also asked to estimate the bird damage in each field according to this percentage scale: 0, 1, 5, 10, 20, 30, 40, 50, >50. It may also be desirable to include additional questions that may be of value to extension specialists, e.g., amount spent on bird control, expectations of governmental agencies, etc. (O. Arrogoces, pers. comm.).

(4) A subsample of the cooperatives selected in (2) is randomly chosen and, in addition to interviewing the 10 farmers in each selected cooperative, the hectarage of each farmer's crop is field surveyed for damage. Note: I suggest that the interviewer should try

to obtain estimates of damage in the interview before the farmers are told that their fields will be assessed. This approach will decrease the likelihood that sampled farmers might respond differently if they knew their fields were going to be assessed.

The efficiency of this design depends on 2 key parameters. The first is the ratio of the costs of conducting an interview versus a field assessment and the second is the strength of the correlation between the loss estimated by the farmer and the loss actually measured in the field. Appendix II contains the statistical derivations and formulas for this design, based in part on estimates of manpower costs developed in discussions with M. E. Zaccagnini (Appendix III). A consequence of this analysis is that the correlation between interview and field assessments must be relatively large (>.7) in order to have to field survey less than one-half of the interviewed farmers (Table 3). If the correlation is low to moderate, then virtually all farmers that are interviewed must also have their fields surveyed. As a reasonable example, Table 3 shows that for an assumed value of $\rho = .7$ and a desired standard error of 0.5 percent for the estimate of percentage loss, the cost of the doubling sampling survey is about $85,000.

Table 3. Sample size and cost requirements for a 1992-3 damage survey using the double sampling design. Rho(ρ) is the theoretical value of the correlation between a farmer's estimate of damage and the actual damage, n' is the number of cooperatives in which only interviews are conducted, and **n** is the number of cooperatives in which both interviews and field surveys are conducted. Cost estimates are based on results from Appendices II and III.

Std. error of percent loss estimate	n	n'	Cost Days	Cost $
		ρ = .5		
1.00	9	8	421	45630
0.50	37	32	1011	87590
0.25	149	130	3374	255440
		ρ = .7		
1.00	8	11	416	45140
0.50	30	45	992	85740
0.25	121	179	3294	248190
		ρ = .9		
1.00	4	13	373	42040
0.50	16	51	820	73190
0.25	65	202	2609	197840

<u>Redesigned Survey Using Two-Stage Cluster Design</u>

The previous survey design tries to minimize cost by using interviews as a cheaper way to obtain damage information. It depends heavily on the assumed correlation between ground and interview surveys and was originally based on the assumption that interviews were <u>much</u> cheaper than ground surveys. Based on actual cost analyses, this difference is not as large as originally assumed, and the attractiveness of the double sampling approach is somewhat reduced. Undoubtedly the most reliable approach is to use ground surveys only; however, it is also of some interest to obtain information from farmers about their perception of damage, cost spent on bird control, etc. Therefore, this survey will employ a two-stage cluster design, in which all selected farmers are <u>both</u> <u>interviewed and their crops are ground surveyed.</u>

A description of the basic features of this design follows; details are provided in Appendix IV.

(1) Lists of cooperatives (first stage unit) and farmers (second stage unit) are developed as before.

(2) A set of cooperatives is randomly selected with replacement and with probability proportional to the number of farmers in the cooperative, as before.

(3) A set of farmers is randomly selected in each selected cooperative. If a cooperative is selected t times in (2), then t sets of farmers are selected without replacement.

(4) Each farmer that is selected is interviewed and his planting of the crop type of interest is field surveyed for damage. The field surveys are used to estimate losses. The

function of the interview is not to provide information to be used in estimating loss, but rather to gather ancillary information of interest, such as dollars spent on bird control. Another essential function of the interview, as was the case in the double sampling design, is to obtain a description of the locations of the fields that will subsequently be assessed for damage.

The statistical formulas and derivations in Appendix IV can be used to perform a cost analysis of this design, the results of which are summarized in Table 4. Note that separate estimates are provided for mature and sprouting crops, based on the assumption that variation in damage within a field tends to be larger in a sprouting vs. mature crop. As a comparison with the double sampling design consider the estimated cost for a survey with precision of 0.5 percent. The estimate in Table 4 is less than $70,000 which is considerably less than the corresponding cost of $85,000 in Table 3. Part of the explanation for the lower cost is that an arbitrary figure of 10 farmers per cooperative was specified for the double sampling design, and this turns out to be higher than the statistically derived sample sizes in the current design. The important message is, however, that the two designs require approximately the same resources. Therefore, my recommendation is that the two-stage cluster design be used.

Table 4. Sample sizes and costs associated with the two stage cluster sampling design. Values of n (cooperatives) and $\overline{m}_{opt}$ (farmers/cooperative) and cost requirements in terms of days and dollars ($) are given for example surveys in which either mature or sprouting crops are surveyed in both field seasons.

Std. error of percent loss estimate	n	$\overline{m}_{opt}$	Cost D	Cost $
		Mature		
1.00	8	3	319	36900
.50	32	3	545	52700
.25	117	3	1344	108600
		Sprouting		
1.00	10	7	370	40700
.50	40	7	748	67700
.25	153	7	2172	169600

FIELD ASSESSMENT OF DAMAGE

The purpose of this section is to provide recommendations concerning (1) sampling design for conducting damage assessment within a field and (2) assessment techniques for specific crop types.

Field Sampling Design

A farmer that is selected for damage assessment is interviewed and the number and location of all of his fields that are planted in the crop of interest are obtained. If the farmer has planted more than one field, one is selected at random for assessment. The length of a baseline of the field is measured, preferably by using the vehicle odometer. Three random points along the baseline are selected and visual estimates of the width of the field are obtained at each point. A random location along the width at each of the 3 points is selected. At each of these 3 locations, the corners of a 10m x 10m square are established and the damage assessment performed at each of the 4 corners.

For purposes of subsequent data analysis, the resultant 12 measurements in a field can be averaged. For a discussion of similar assessment designs, see Otis (1989).

Damage Assessment Methods

Sprouting soybean and sunflower

In 2 adjacent rows, the number of damaged, intact and removed seeds/sprouts in a 1 m segment are recorded. The field should be surveyed before sprouts reach a height greater than 10 cm, i.e., between 1 and 3 weeks after planting (M. E. Zaccagnini, pers. comm.). The percentage loss should be calculated by dividing the sprouts removed by the

total in all 3 categories. This procedure assumes that damaged plants will ultimately compensate for their injury and produce normal yield. The investigator may wish to develop specific criteria for categorizing damaged versus destroyed plants.

Mature sunflower

In 2 adjacent rows, a 2 meter segment is identified and for each plant, the head diameter is measured using a tape measure. A wire cross (Dolbeer 1975) is used to visually estimate percent loss in each of the 4 quadrants of the head, using a scale of 0, 1, 5, 10, 25, 40, 50, 60, 75, 90, 100. The estimated loss in the field can be taken as the average over all measured plants, weighted by the square of the head diameter. Thus, for example, if (y_i, d_i) represents the estimated percent loss and head diameter of the ith head, then $\overline{Y} = \Sigma y_i d_i^2 / \Sigma d_i^2$.

Mature Sorghum and Barley

The procedure is similar to that for mature sunflower, except that, instead of measuring head diameter as an index to size, the length of the ith head is measured on 2 opposite sides and the average p_i is used as the index. The lengths of damage on 4 sides of the head are measured and averaged (y_i). The estimate of percent loss in the field is then obtained by calculating the weighted average over all measured heads, i.e., $\overline{Y} = \Sigma y_i p_i / \Sigma p_i$.

ORGANIZATION AND TRAINING

A single person who is competent in statistical techniques, data processing and data analysis and interpretation should be designated as the survey coordinator. As many as one coordinator per region or province could be designated as assistants responsible for the conduct of the survey in their region. All data should be sent to a single facility, presumably the coordinator's location, for processing and analysis.

The survey should be conducted only after a training workshop is held for the personnel that will be collecting the data. The workshop should be about one week in length, and involve:

(1) Overall description of the objectives of the survey.

(2) Review of interview questions and techniques.

(3) Detailed exercises on procedures for conducting damage assessments, e.g., locating sample plots in fields and use of damage assessment techniques. These exercises should include simulated field exercises in which the instructor actually takes the class through all the necessary steps at a field site.

(4) Calibration exercises with damage assessments should be conducted in order to improve the ability of surveyors to accurately assess damage. Participants should be asked to assess samples of plants that have been assessed by the instructor via an exact technique that is practical only for this purpose, e.g., complete counts of seeds missing and remaining. Based on their responses, the participants can work to reduce biases in their personal assessment technique.

(5) Data handling requirements and procedures should be described.

A rough estimate of the cost of this workshop is $10,000. Because the results of a survey conducted without adequate training will be suspect, this cost should be incorporated into the overall cost estimate of any contemplated survey.

FINAL COMMENT

The design ideas and recommendations in this report are the result of previous experience and a brief exposure to the agricultural and ecological systems in the binational area. If the decision is made to proceed with a large scale survey in the short term, I am sure that some details and procedures of the design will have to be altered, some perhaps significantly. However, I believe that the basic approach I have presented is feasible and that an adequate survey of the binational region can be accomplished for less than $100,000. It will, however, require a strong, coordinated commitment from both countries and should be viewed in the context of a renewed effort to pursue a systematic, well-conceived long term program of research and extension that will address the needs of the agricultural community by producing cost-effective, environmentally responsible management strategies for bird problems.

APPENDIX I.

TERMS OF REFERENCE

International Consultant Specializing in Agricultural Bird Pest Damage Evaluation

Duration: 1 month

Destination: SGBA, Salto Grande, Uruguay

Activities:

Analyze existing information about problems in the region and the economical and social impact (from damage losses) due to bird pests (doves, pigeons, parakeets) in agriculture.

Propose information currently necessary for (evaluating?; quantifying?) the negative impact due to bird pest problems in the binational agricultural area.

Propose and participate in the gathering of information necessary to diagnose the possible negative impact of bird pests.

Visit areas in order to recognize and diagnose the problem.

Develop the evaluation of the 'economic and social impact of bird pests' component in the program for integrated bird pest (management?).

Collaborate with the project leader, the consultant in program and project development, and other project consultants in the development of the funding proposal.

Participate in training activities concerning evaluation of the impacts (damage, losses etc.) caused by agricultural bird pests.

Prepare a technical report in Spanish with observations, conclusions, and recommendations, to assure that the evaluation of the impacts (economic and social) can be adequately developed for the (integrated?) bird pest management program.

APPENDIX II. DOUBLE SAMPLING DESIGN

Notation and Definitions

Let a cooperative be defined as the first stage (primary) sampling unit and farmers within a cooperative are the second stage units (elements). Let

N = Total number of cooperatives,

M_o = Total number of farmers,

M_i = Number of farmers in the ith cooperative,

X_{ij} = The estimate of percent crop[1] loss that would be given by farmer j in cooperative i in an interview,

Y_{ij} = Percent loss in the total crop planted by the jth farmer in the ith cooperative,

ρ = Population correlation between Y_{ij} and X_{ij}

n' = Number of cooperatives chosen for conducting interviews,

n = Number of cooperatives chosen for conducting both field surveys and interviews,

$\overline{m}$ = Number of farmers that are interviewed or that have their field surveyed in a selected cooperative,

$\overline{y}_i$ = Average percent loss in surveyed fields in the ith cooperative, $i = 1, ..., n$,

$\overline{x}_i'$ = Average estimated percent loss by farmers interviewed in the ith cooperative, $i = 1, ..., n'$,

$\overline{x}_i$ = Average estimated percent loss by farmers that were both interviewed and field surveyed, $i = 1, ..., n$.

[1] The term crop is used to refer to whatever specific crop type is being surveyed.

In practice, cooperatives are selected with replacement and with probability proportional to the number of farmers in the cooperative. If a cooperative is selected more than once, say t times, then $t\overline{m}$ farmers are selected without replacement.

For purposes of cost analysis and comparison we will take advantage of Cochran's (1977) results (pp. 334-8). Although these results are based on assumptions of simple random sampling at both stages, they provide a guide to results that can be expected for our specific design.

The estimator of percent loss in the entire region that is surveyed is:

$$\bar{\bar{y}}=\Sigma\bar{y}_i\;/n+b(\Sigma\bar{x}_i\;/n'-\Sigma\bar{x}_i\;/n),$$

where b is the estimated regression coefficient of $\bar{y}_i$ on $\bar{x}_i$. The variance of the estimate is given by

$$Var(\bar{\bar{y}})=S_y^2\frac{(1-\rho^2)}{n}+\frac{\rho^2 S_y^2}{n'},$$

$$where \quad S_y^2=\frac{1}{n}\Sigma\frac{(M_i)}{\overline{M}}\;\frac{(\overline{Y}_i-\overline{Y})^2}{N}.$$

If we follow Cochran (p. 331) and assume a simple cost function

$$C=nC_n+n'C_{n'}+C_o, \quad where$$

C = Total cost of the survey,

C_n = Cost per cooperative in which both field surveys and interviews are conducted,

$C_{n'}$ = Cost per cooperative in which only interviews are conducted,

C_o = Starting costs (equipment, development of cooperative lists, etc., that are independent of sample size,

then the optimum choice of n and n′ can be determined by the relationships

$$\frac{n}{n'} = \left(\frac{(1-\rho^2)}{\rho^2} \frac{C_{n'}}{C_n} \right)^{1/2},$$

$$Var\,(\bar{\bar{y}}) = \frac{S_y^2}{C} \left(\sqrt{(1-\rho^2)C_n} + \rho\sqrt{C_{n'}} \right)^2.$$

The values in Table 3 were produced using these formulas and a value of $S^2_y = 9$, as determined from data reported by Hothem et al (1988) in their large survey of sunflower losses in the north-central United States.

APPENDIX III. COST ANALYSIS OF INTERVIEW AND FIELD SURVEYS

Task	Manpower Requirements (Days)	Conversion to Dollars
Development of lists of cooperatives and farmers	120	120 x \$60/day salary = \$7200
Selection of cooperatives and farmers	2	2 x \$60/day salary = \$120
Organizing interviews	2/cooperative	2 x \$60/day = \$120/ cooperative
Travel to cooperative	.5/cooperative	\$22.50 vehicle cost + \$20 per diem + \$12.50 salary = \$55/cooperative
Conduct interviews	.5/cooperative	\$20 per diem + \$12.50 salary = \$32.50/cooperative
Conduct field surveys	.3/field/cooperative	\$5 vehicle cost + \$7.50 salary + \$12 per diem = \$24.50/field/cooperative
Process and analyze interview data	.5/cooperative	.5 x \$60/day salary = \$30/cooperative
Process and analyze field data	.1/field/cooperative	.1 x \$60/day salary = \$6/field/cooperative
Report preparation	60	60 x \$60/day salary = \$3600

All of the above costs, with the exception of the cost of the first task and equipment, would be doubled for a design that required both fall and spring surveys. In addition, there are the following operating costs:

Equipment (microcomputer)	$5000
Telephone charges supplies	$10,000
Publication	$2000

APPENDIX IV. TWO STAGE CLUSTER DESIGN/COMBINED INTERVIEW AND GROUND SURVEY

Notation and Definitions

Let a cooperative be defined as the first stage sampling unit (primary unit), and farmers that belong to a cooperative are defined as the second stage sampling unit (elements) The third stage unit (within fields) is ignored.

Let

N = Total number of cooperatives,

M_o = Total number of farmers,

M_i = Number of farmers in the ith cooperative,

Y_{ij} = Percent loss to a given crop received by the jth farmer in the ith cooperative,

X_{ij} = A response given by the ith farmer in the ith cooperative to a question posed in the interview survey,

S^2_{wi} = Variance in a response Y_{ij} or X_{ij} among the j elements in the ith cooperative,

n = Number of randomly selected cooperatives to be sampled. Cooperatives are sampled with replacement and with probability proportional to the number of farmers in the cooperative,

m_i = Number of farmers surveyed in the ith selected cooperative. If the ith cooperative is selected t times, then tm_i elements are selected from M_i.

From Cochran (p. 308), we know that the unbiased estimator of $\overline{Y}$ (or $\overline{X}$, but we

will use Y for illustration), the true population mean of Y_i, is

$$\bar{y} = \frac{1}{n}(\bar{y}_1+\bar{y}_2+\bar{y}_3+...\bar{y}_n), where$$

$$\bar{y}_i = \sum_{j=1}^{m_i} y_{ij} / m_i$$

y_{ij} = *Sample response of the jth farmer in the ith cooperative.*

Also,

$$Var(\bar{\bar{y}}) = \frac{1}{n}\sum\frac{M_i}{M_o}(\bar{Y}_i-\bar{Y})^2+\frac{1}{n}\sum\frac{M_i}{M_o}\frac{S_{wi}^2}{M_i}(1-f_{2i}),$$

$$V\hat{a}r(\bar{\bar{y}}) = \frac{1}{n(n-1)}\sum(\bar{y}_i-\bar{\bar{y}})^2.$$

$$Assume \quad m_i / M_i = f_o, \qquad \bar{m} = \sum^{n} m_i / n.$$

$$Rewrite \quad Var(\bar{\bar{y}}) = \frac{1}{n}\sum^{n}\frac{Mi}{\bar{M}}\frac{(\bar{y}_i-\bar{Y})^2}{N}+\frac{1}{n\bar{m}}\sum\frac{M_i}{M_o}S_{wi'}^2-\frac{1}{n\bar{M}}\sum\frac{M_i}{M_o}S_{wi}^2$$

$$= \frac{1}{n}(S_1^2-\frac{S_2^2}{\bar{M}})+\frac{1}{n\bar{m}}S_2^2,$$

$$where \quad S_1^2 = \sum^{n}\left(\frac{M_i}{\bar{M}}\right)\frac{(\bar{Y}_i-\bar{Y})^2}{N},$$

$$S_2^2 = \sum^{n} \frac{M_i}{M_o} S_{wi}^2 \ ,$$

$$\overline{M} = \Sigma M_i \ / N \ .$$

Following Cochran (p.314),

$$\overline{m}_{opt} = \frac{S_2}{\sqrt{S_1^2 - S_2^2 \ / \overline{M}}} \sqrt{\frac{C_1}{C_2}}$$

where

C_1 = cost per primary unit,

C_2 = cost per element,

and a cost function

$C = C_1 n + C_2 n \overline{m} + C_o$ is assumed,

where

C = Total cost of field survey work,

C_o = Starting costs (equipment, development of cooperative lists, etc.) that are independent of sample size.

Based on values taken from Appendix III, I estimate $(c_1/c_2)^{1/2} = 3$. Based on analysis of several hypothetical sets of $\{\overline{y}_i\}$, I chose a value of $S_1^2 = 6$. Finally, I assumed an average of 300 farmers per cooperative. Substituting these values into the above equation for $\overline{m}_{opt}$ we have

$$\overline{m}_{opt} = \frac{3S_2}{(6-S_2^2/300)^{1/2}} = 1.22\ S_2,$$

assuming $S_2^2/300$ is negligible.

Now, for mature crops assume a value of $S_2 = 2$, and for sprouting crops assume $S_2 = 5$. These values are based upon my experience that amount and variation in damage in sprouting crops is likely to be greater than for mature crops. These values translate into $\overline{m}_{opt}$ = 7(sprouting), 3(mature).

We now have the information necessary to calculate sample sizes and cost estimates for surveys of specified precision. Examples are given in Table 4.

TRIP REPORT*

Assessment of 1990/91 Vertebrate Pest Control Activities
(including involvement in National Rodent Control Campaigns)
and development of cooperative research plans for 1992

BANGLADESH

October 28-November 26, 1991

by

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Unpublished Report

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ITINERARY

Date	Location	Activity
October 28	Departed Denver	Travel
October 29	Arrived London	Met with Dr. A. Buckle, ICI, Haslemere
October 30	Departed London	Travel
October 31	Arrived Dhaka	On duty, Bangladesh
November 25	Departed Dhaka	Travel
November 26	Arrived Denver	Travel

SUMMARY

The Bangladesh Agricultural Research Institute (BARI) was visited to review the research and training accomplishments of the Vertebrate Pest Section (VPS) over the last 14 months and to plan for cooperative work over the next 19 months. A National Rodent Control Campaign, using technology developed over more than 10 years of cooperative research with DWRC, was conducted from October 15-29, 1991. Plans were made for evaluating the impact of this campaign in farmers' fields by surveying 640 randomly selected farmers and assessing 4,600 randomly selected fields for rodent damage. Also, scopes of work were outlined for 10 additional consultancies to Bangladesh in 1992 and 1993 involving research on rodent, bird and predator pest problems. En route to Bangladesh, I visited Dr. Allan Buckle in England to discuss progress on a chapter being written for a rodent book that Dr. Buckle is co-editing.

OBJECTIVES

DWRC has provided full-time technical assistance to the BARI/VPS since 1978. Dr. Jaeger, the most recent project leader, returned to the United States in August 1990, after which project support was to be continued with temporary duty assignments (TDY's). However, due to unforeseen delays in obtaining clearances, this is the first TDY implemented since that date. The original objective of this TDY was to review and revise, if necessary, the National Action Plan for Rodent Control in Bangladesh, developed in 1990 by BARI/VPS. However, since the 1991 National Rodent Control Campaign had just been completed, the primary objective was changed to provide assistance in planning the evaluation of the campaign. Another objective was to review and revise DWRC project support of the research and extension activities of the VPS and the Department of Agricultural Extension (DAE) for current and future needs over the remaining life of the project. Also, specific research activities currently being conducted or planned needed reviewing to provide appropriate suggestions for improving expected outcomes.

ACTIVITIES

Logistical support to facilitate this consultancy was arranged through Dr. Ray Morton and Mr. Habibur Rahman of the Office of Food and Agriculture, U.S. Agency for International Development (USAID). Dr. Md. Abdul Karim, Head, Division of Entomology, BARI, and personnel within the VPS were briefed on the purpose of this consultancy. The VPS provided a review of their activities during 1990-91 which are summarized:

National Rodent Control Campaign Evaluation

The DAE had recently requested Dr. Karim to coordinate an independent evaluation of the 1991 National Rodent Control Campaign and to complete it within 45 days of the campaign. Therefore, assistance was provided to develop an evaluation plan. Necessary questionnaires and forms were drafted for interviewing extension personnel, pesticide dealers, and farmers in 16 of 64 total districts. Four districts were randomly selected within each of four major divisions of Bangladesh. Two upazilas (administrative units) in each selected district were then randomly selected, as well as 2 blocks (extension units) within each selected upazila. In each selected block, 10 farmers will be randomly selected from a current list of farm families maintained by the extension block supervisor. In addition to extension personnel, a total of 640 Bangladeshi farmers will be questioned regarding their participation in the National Rodent Control Campaign, and 640 fields will be examined to determine the number of active rodent burrows present. Fields with rodent control will be compared to those without any control. Meetings with DAE and BARI officials resulted in a basic agreement to this format. Appendix I presents background information related to rodent control in farmers' fields as well as draft survey forms recommended for the evaluation.

Project Personnel

VPS personnel have changed somewhat since August 1990. A new Scientific Officer, Mr. Habibur Rahman, has joined the staff and Dr. Parvin Sultana, who has been "on lien" for the past 6 months to work with another program, is currently on medical leave. Personnel currently assigned to the project are:

Dr. Md. Abdul Karim, Head, Division of Entomology
Mr. Md. Emdadul Haque, Senior Scientific Officer, VPS
Dr. Parvin Sultana, Senior Scientific Officer, VPS
Mr. Yousuf Mian, Senior Scientific Officer, VPS
Mr. Rajat K. Pandit, Scientific Officer, VPS
Mr. Habibur Rahman, Scientific Officer, VPS
Mr. Jalal Uddin, Clerk/Typist
Mr. M. Mia, Laboratory Attendant
Mr. M. Rahman, Laboratory Staff
Mr. Jamal Uddin, Laboratory Staff

Research in Progress

Vertebrate pest management research conducted by VPS staff in 1990-91 was reviewed. Four studies have been completed including:

1. Rodent and jackal damage assessment of sugarcane (R. K. Pandit, M. E. Haque, and M. A. Karim),

2. Estimation of livestock losses due to vertebrate predators (R. K. Pandit, M. E. Haque, and M. A. Karim),

3. Bird damage assessment in maize (M. H. Rahman and P. Sultana), and

4. Efficacy of three carbamate insecticides in controlling bird damage to fox-tail millet (M. B. Uddin, M. A. Karim, and P. Sultana).

Field research activities have been limited due to low per diem rates, government travel restrictions on vehicles moving between different districts, and a lack of money to maintain supplies, equipment and facilities. Despite these constraints, some research has been completed, some is now being done, and some is scheduled to be completed by June 1992. Manuscripts in various stages of preparation include:

1. Haque, E. and R. Pandit. (Accepted). Vertebrate pests and their control (in Bengali). Bangla Academy, Dhaka, Bangladesh.

2. Haque, E. and R. Bruggers. (In prep). Notes on zinc phosphide analyses.

3. Haque, M. E., J. E. Brooks, R. K. Pandit, and S. Ahmed. (Submitted). Farmers perceptions of the jackal (*Canis aureus*) as an agricultural pest in Bangladesh. Crop Protection.

4. Ahmed, S., R. K. Pandit, and J. E. Brooks. (In prep). Postharvest losses in farm houses in Bangladesh: rodent population estimates and potential food grain losses. Denver Wildlife Research Report Series.

5. Haque, E. and M. M. Jaeger. (In prep). Jackal censuses in Ishurdi area (radiotelemetry on jackal at Ishurdi).

6. Pandit, R., M. M. Jaeger, and M. E. Haque. (In prep). Factors influencing the responsiveness of golden jackals to broadcasted howling.

7. Brooks, J. E., M. W. Fall, M. E. Haque, and R. K. Pandit. (In prep). Immobilization of golden jackals with ketamine.

Training

Formal graduate degrees are being pursued by Mr. Yousuf Mian at Colorado State University, Fort Collins, Colorado, and Mr. Emdadul Haque at Dhaka University in Bangladesh. Mr. Haque has completed course requirements and is finishing his doctoral thesis. Also, Mr. Santosh K. Sarkar, DAE, is writing his thesis for a doctoral degree at Dhaka University. Both theses were reviewed during this consultancy and comments provided to the authors.

During the past 2 years, project scientists both participated in and provided specialized training courses.

Training Given:

1. Prior to the National Rodent Control Campaign, training on rodent control techniques was given by Mr. Haque and Dr. Karim to district Deputy Directors and Subject Matter Specialists within the DAE in the Dhaka Division (34 participants), Chittigong Division (30), Rangpur Division (32), and Jessore Division (32).

2. Mr. Pandit presented information on vertebrate pest damage and conducted field visits for 27 Ministry of Agriculture (MOA) Scientific Officers and Seed Analysts in the BARI training course "Collection and Identification Techniques of Plant Pest and Diseases," held on August 26-31, 1991.

Training Received:

The Bangladesh Agricultural Research Council (BARC) and BARI sponsored the training course "Research, Planning and Evaluation" at the BARI facilities; this course was attended by Mr. Pandit (April 4-19, 1990), Mr. Haque (March 10-25, 1990), and Mr. H. Rahman (October 23-November 6, 1990).

Future training needs for the VPS/BARI staff were reviewed. Available training courses and workshops scheduled in 1992 that would be useful include:

1. Statistics Training/Workshop for Field Ecology and Resource Selection, Fort Lewis College, Durango, Colorado, U.S.A., January 4-10, 1992,

2. The 15th Vertebrate Pest Conference, Newport Beach, California, U.S.A., March 3-5, 1992, and

3. The 2nd International Course on Vertebrate Pest Management with emphasis on Developing Countries, Bowling Green State University, Bowling Green, Ohio, U.S.A., May 19-June 18, 1992.

It is recommend that Dr. Karim attend the "Statistics Training/Workshop for Field Ecology and Resource Selection," that Dr. Sultana attend the "15th Vertebrate Pest Conference", and that Mr. Haque and Mr. H. Rahman attend the "2nd International Course on Vertebrate Pest Management with Emphasis on Developing Countries." Some other courses will probably become available in late 1992 or early 1993 and, if so, other VPS staff should be encouraged to participate if funds are available.

Project Facilities

Facility repair and construction needs were reviewed. The IBM PC and accessories have some minor problems which need attention. The SAS statistical program needs an expiration date renewal, the external tape backup system is not operational, and the Hard Disk Management Program is not accessible through normal keyboard/menu steps. A computer virus, calling itself "Dark Avenger," was discovered on the system carrying the message "Dianna P. This message was written in the city of Sofia (c) 1988-89. Eddie lives ... somewhere in time!" Thus far, this virus has not resulted in any known data loss or system damage. Everything else, from power supply and regulation to the printer, is functioning well; however, the system would be greatly enhanced by upgrading the wordprocessing software from WordPerfect 5.0 to 5.1, and MS-DOS from 4.0 to 5.0.

Construction of a detached animal facility and remodeling of the computer room and library/conference room, including installation of an air conditioner, was to be completed some time ago utilizing PL-480 money. However, no formal request for funds was submitted. This request needs to be submitted as soon as possible by the VPS to the Department of Entomology Head, Dr. Karim, for approval and then forwarded to the Director General of BARI, Dr. Mondol. After approval from Dr. Mondol, it should be forwarded to BARC, as No PL-480 monies will be available until USAID receives the request from BARC.

Future Research

Research plans for 1991-92 were discussed and reviewed with each principal investigator:

Mr. Ranjat Pandit will determine the predation capacity of jackals, jungle cats, and possibly other predators of the lesser bandicoot rat (*Bandicota bengalensis*) in an enclosure. He will also develop glues made from locally available ingredients for use in rodent control.

Mr. Emdadul Haque will be evaluating laboratory and field efficacy of rodenticide products in the lab and in the outdoor animal enclosure. He will also attempt to establish a breeding pen for *B. bengalensis* to serve as a supply of test animals. He will also begin a study on the control of the short-tailed mole rat (*Nesokia indica*) at Ishurdi, where he will compare rodenticide and trapping techniques; and, if time permits, study the biology, ecology and control of *B. bengalensis* at Gezaria, Bangladesh.

Mr. Habibur Rahman has begun studies on assessing bird damage in maize and evaluating carbamate and organophosphate insecticides as seed-treating chemicals for reducing bird damage to sprouting maize seeds.

Logistical Considerations

We discussed possible methods for communicating between DWRC and the VPS and concluded that methods that have been used, such as the IRRI Office fax, USAID telex and fax, and international mail, supplemented with using future consultants to transmit items to and from Bangladesh, will be sufficient avenues to coordinate project activities over the next several months. The local mailing address at BARI/VPS is:

Vertebrate Pest Section
Entomology Division
BARI
Joydebpur, Gazipur, BANGLADESH

Equipment and supplies needed for research and training activities that are not locally available include:

1. Six red flood lights for use in videotaping nocturnal animal behavior in the outdoor enclosure

2. Six to 12 Tungsten Halogen Projector Lamps (Sylvania ENH 250 watt, 150 volt) for the Kodak Carousel Model No. 750 HA.R Multivoltage Projector (bulbs tend to blow out regularly)

3. Repair of the Powermaster 760, 0.177 Cal. Pellet/BB Repeater Crossman Airgun Model 760-A

4. Some English lesson books and tapes

5. Five multiple-catch rodent traps

6. Some wildlife video tapes for use in training

7. Literature references needed by research staff: Bronson, F. H. 1979. The reproductive ecology of the house mouse. The Quarterly Review of Biology 54:265-299; and reprints on rodent and bird glues that may be available

RECOMMENDATIONS

1. A schedule of consultancies necessary to support the project was drafted and attached as Appendix II.

2. Using an effective anti-virus program, DWRC, via the next consultancy, should remove the "Dark Avenger" virus from the VPS/BARI computer.

3. The current extension literature on rodent control for farmers is too general. A simple 1-3 page leaflet, describing specific procedures for farmers to easily follow, is needed.

4. The two-season strategy for controlling rodents in Bangladesh needs to be incorporated into the annual rodent campaign agenda. The first season for control is July-August for postharvest rodent control in village homes which store boro rice harvest. The second control season is in September-October for preharvest rodent control of aman rice, boro rice, and wheat. Rodent populations in homes are highest in August, after the boro and aus rice harvest and again in January, after the aman harvest. Currently there is only one control period (the second season) that is being used by Extension.

5. Although bounties do create a lot of enthusiasm in rodent control campaigns, they are mostly ineffective in reducing losses of preharvest or stored grain. Emphasis on bounty programs should be reduced and the time involved devoted to initiating the two-season strategy mentioned in recommendation 4.

6. The emphasis on cooperative or area-wide rodent control should be shifted to individual farmers who wish to control rodents in their fields, irrespective of whether adjacent fields are being subjected to any rodent control or not. Area-wide rodent control requires a lot of Extension effort that could be better used to provide assistance to those farmers eager to reduce losses in their fields.

7. Bangladeshi farmers should not be mixing their own zinc phosphide rodenticide bait in their villages or homes for use in field crops. This practice is unnecessary and potentially hazardous. The commercial manufacture of zinc phosphide bait cakes by private companies should be encouraged. The rodenticide product can be marketed at a profit and still be very affordable (10 Taka, or $ 0.26) by even cash-poor farmers. Quality control of ingredients and finished products could be monitored at a much more efficient level than now possible. The imported zinc phosphide concentrate used and the finished product produced could be monitored at formulation sites, which would be fewer in number compared to the large number of small-packet zinc phosphide concentrate formulators now operating. The current system allows a substantial amount of adulterated zinc phosphide concentrate to enter the country and be further adulterated. Farmers can not readily detect adulteration until after the product is purchased and used.

CONTACTS AND ACKNOWLEDGMENTS

USAID/DHAKA, Office of Food and Agriculture

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Mr. Jalal Uddin, Clerk/Typist
Mr. M. Mia, Laboratory Attendant
Mr. M. Rahman, Laboratory Staff
Mr. Jamal Uddin, Laboratory Staff

Bangladesh Department of Agricultural Extension (DAE)

Dr. Anwarul Kibria, Director of Field Services (Deceased Nov. 11, 1991)
Mr. Santosh K. Sarkar, Rodent Control Specialist, Plant Protection Wing

Bangladesh Rice Research Institute (BARI)

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APPENDIX I

EVALUATION OF BANGLADESH RODENT CONTROL CAMPAIGN
November 24, 1991

OBJECTIVE: To determine the effectiveness of the National Rodent Control Campaign conducted October 15-29, 1991.

PURPOSE: To gather information that will (1) identify the successes and constraints of the 1991 rodent control campaign and (2) provide useful information for planning and improving the 1992 and subsequent National Rodent Control Campaigns.

BACKGROUND: Annual rodent campaigns have been conducted by the Ministry of Agriculture in 1983 and 1984 and from 1986 through 1990. The campaigns conducted in 1983 and 1984 provided participating farmers with free rodenticide bait. Evaluations of 1983 and 1984 campaigns demonstrated reduced damage resulting in an increased wheat harvest of about U.S. $800,000 (Adhikarya and Posamentier, 1987). Campaigns conducted since 1986 have required individual farmers to purchase their own rodenticide bait from a local dealer in hopes of establishing a program in which farmers are not dependent upon government distribution of rodenticide bait.

In 1990 an "Action Plan For Rodent Control in Bangladesh" was organized by a select task force composed of representatives from agencies involved in rodent control research, extension, and operations. This action plan recommended two effective periods for rodent control. The first is in July-August, when monsoon rains cause field rodents to move to higher ground. At this time, rodent control in villages and in other areas situated above flood waters are designed to reduce losses of stored grain and other food products. The second period recommended for controlling rodent damage is in September-October, after peak monsoon rains, for protecting preharvested aman rice. Monsoon flooding causes high mortality in rodent pest populations. Rodents that survive floods are usually concentrated on high ground and remain there until waters recede, before re-entering crop fields. In September-October, field rodent pest populations are most susceptible to control, and protection of aman rice crops and the subsequent wheat crop is more efficacious and cost-effective than at any other time of the year.

The 1990 Action Plan proposed specific recommendations for implementing a short-term (2-year) strategy involving only a select number of districts in Bangladesh, followed by a long-term strategy involving all of Bangladesh. Unfortunately, funds to implement this short-term strategy were not available. However, PL-480 money was obtained to conduct a smaller pilot study to evaluate the effectiveness of a rodent control campaign conducted from September to December, 1990, by the Department of

Agricultural Extension (DAE) Plant Protection Wing. The pilot study, conducted in three upazilas each in Comilla and Jamalpur Districts, offered training on proper rodent control techniques by DAE to the district extension officers, who in turn trained their upazila extension officers, who trained their block (extension units within the upazila) supervisors, who trained about 80 contact farmers (farmers who receive regular assistance from the block supervisor), who, in turn, trained other farmers in their block. Either zinc phosphide concentrate or Klerat®[1] wax block rodenticides, together with leaflets containing general rodent control information, were supplied by DAE to extension personnel and farmers.

Farmers and fields in the treated as well as untreated blocks were then randomly selected from a block supervisor list and surveyed to determine effectiveness of the pilot study (Sarkar, 1991). Training reached more than 90 percent of the contact farmers and about 50 percent of other farmers. A majority of trained farmers prepared zinc phosphide bait cakes by following the formula provided in the training. About 80-90 percent of both contact and other farmers ranked rodenticide effectiveness "good" to "very good." Lack of money or unavailability of rodenticides was not a major constraint for farmers wanting to control rodents, but rather the lack of knowledge on how to control rodents. This survey also revealed that only 15.1% of contact farmers and only 21.1% of block supervisors participating in the study had knowledge of proper rodenticide bait placement. Even though more than 50% of contact farmers knew how to prepare zinc phosphide bait, very few knew how to correctly apply it.

Khan (1991) interviewed 37 farmers and 24 extension personnel in Comilla and 51 farmers and 32 extension personnel in Jamalpur and concluded that the present rodent control technology is simple, understandable, and cost-effective, but that technical competence at local levels needs improving. He noted several constraints: under the present system, contact farmers have not been effective in transferring information to other farmers within their block; that DAE funding for National Rodent Control Campaigns has been very low; and that efforts should be made to develop a simple leaflet on "Rats and their control" for distribution to farmers. He also recommended returning to the two-season strategy and offering more practical "how to" training for extension workers and farmers.

In another evaluation of Bangladesh rodent control practices, Hossain (1990) surveyed 100 randomly selected farmers, each from Comilla in December 1989 and from Iswardi in January 1990. About 75% of Iswardi farmers and 67% of Comilla farmers used rodenticides, while only about 22% practiced no rodent control. However, the majority of those who used rodenticides did so on

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

only a portion of their cropland. The most important reasons given for not conducting any rodent control were:

1. No effective rodenticide	11/58	(19%)
2. No significant damage	9/58	(15%)
3. No capital	8/58	(14%)
4. Forefathers did not adopt	8/58	(14%)
5. Other	22/58	

Most farmers (92/200) felt that farmers should make rodent control decisions themselves, rather than using local leaders or government agencies.

METHODS: For this evaluation, selected farmers and extension personnel will be surveyed to determine participation in the 1991 National Rodent Control Campaign. In addition, farmers' fields will be examined for the presence of active rodent burrows to determine the effectiveness of rodent control methods used in aman rice and other crops affected by rodent damage at this time of the year. Other information will be gathered from dealers to determine rodenticide availability and from farmers to determine rodent control methods used and whether or not these methods were properly used.

Bangladesh is divided into four administrative units, nearly equal in size, called divisions, which contain 15-17 districts each. Three districts in the Chittigong Hill Tract area will not be included. From the 61 districts appropriate for sampling, 16 districts will be randomly selected; and within each selected district, 2 upazilas will be similarly selected; and within each selected upazila, 2 blocks (designated areas assigned to extension agents called block supervisors) will be selected; and within each block, 10 farmers will be selected. Thus, 640 farmers will be surveyed:

DISTRICTS x	UPAZILAS x /DISTRICT	BLOCKS x /UPAZILA	FARMERS = /BLOCK	TOTAL FARMERS
16	2	2	10	640

SAMPLING DATA SUMMARY

	DISTRICTS	UPAZILAS	BLOCKS	FIELDS
TOTAL AVAILABLE	61	460	13,800*	3,450,000**
NUMBER SAMPLED	16	32	64	640
PERCENT SAMPLED	6.6	7.0	0.5	0.02

* Based on 30 blocks/upazila
** Based on 250 fields/block, average farm size, 0.82 ha

In addition to this survey, the Department of Agricultural Extension (DAE) will also assess rodent damage in 4,600 aman rice fields (10 fields in each of 460 upazilas). Based on the estimate of 3,450,000 total fields, the sample size would be about 0.13% of available fields in Bangladesh. In each selected field, rodent cut and uncut tillers will be counted in each of 10 selected quadrats evenly distributed along a transect line that begins from one randomly selected corner of each field and ends at the opposite corner. This assessment will provide a baseline for comparing rodent damage after each subsequent National Rodent Control Campaign. Areas with higher rodent damage can then be selected for greater emphasis in future campaigns.

Rodenticide quality, particularly retail zinc phosphide concentrate, has been challenged based on laboratory analyses conducted by DWRC for the VPS/BARI. Therefore, at each surveyed block, one randomly selected dealer will be visited and one package of each zinc phosphide product available will be purchased, labeled, packaged in a sealed plastic bag and brought to the VPS laboratory for bioassay tests on caged rodents. At least four randomly selected packages of each marketed brand will each be tested on four randomly selected *B. bengalensis* offered a no-choice bait made according to recommendations with the test rodenticide.

SURVEY FORM FOR SELECTED DISTRICT OFFICES

DISTRICT____________________________

DATE________________________________

INTERVIEWER Name____________________

INTERVIEWED OFFICIAL Name____________________

Position________________

Did you know about the October National Rodent Campaign? Yes No

Were you informed by the DAE Headquarters? Yes No

Did you prepare an action plan for rodent control? Yes No

If yes, what were the main activities? ________________________________

____

____

What assistance did you provide to:

Upazila Krishi Officers:

No.____ Assistance____

____

____

____

Others:

Organization ____

Type of assistance ____

____

____

Organization ____

Type of assistance____

____

____

SURVEY FORM FOR SELECTED UPAZILAS

DISTRICT__________________________
UPAZILA___________________________
DATE________________
INTERVIEWER Name___________________
INTERVIEWED OFFICIAL Name____________________
Position________________

Did you know about the October National Rodent Campaign? Yes No

Were you informed by the District Office? Yes No

If yes, what assistance was given to you?_________________________________

What assistance did you provide to:

Block Supervisors:

No.____ Assistance____

Others:

Organization ____
Type of assistance ____

Organization ____
Type of assistance____

SURVEY FORM FOR SELECTED BLOCK SUPERVISORS

DISTRICT___________________________
UPAZILA___________________________
BLOCK_____________________________
DATE________________
INTERVIEWER Name____________________
BLOCK SUPERVISOR Name____________________
Position________________

Did you know about the October National Rodent Campaign? Yes No

Were you informed by the Upazila Krishi Officer? Yes No

If yes, what assistance was given to you?_________________________________
____
____

What assistance did you provide to:

Villages, No.____ Assistance_______________________________________
____
____
____

Contact Farmers No. ____ Assistance________________________________
____
____
____

Other Farmers No. _____ Assistance_________________________________
____
____
____

SURVEY FORM FOR SELECTED FARMERS

DISTRICT_______________________________
UPAZILA_______________________________
BLOCK_________________________________
DATE_________________
INTERVIEWER Name___________________
FARMER Name____________________
Village___________________

1. Did you know about the October rodent control campaign? Yes No

2. Were you informed by the block supervisor? Yes No

3. Are you a contact farmer? Yes No

4. Did you control rodents during the campaign? Yes No

A. If yes, what rodent control measures were done?
__Rodenticide baiting
__Other (go to question 6)

B. If not, why not?
__Unnecessary, no rodent problems
__Not enough time
__Didn't know how
__No money
__No rodenticide available
__Other, Explain________________________
____
____

5. If rodenticides were used:

A. What rodenticides were used?
__Zinc phosphide, Brand name______________________
__Klerat (brodifacoum)
__Lanirat (bromadiolone)
__Phostoxin (aluminum phosphide)
__Racumin (coumatetralyl)
__Other, ____
If a rodent concentrate such as zinc phosphide was used, how did you prepare it?____
____
____

B. Where was the rodenticide used?
__Home (__burrows__bait containers__other)
__Fields (__burrows__bait containers__other)
__Other (__burrows__bait containers__other)

C. If the rodenticide was used in the field, what crops?
__Aman rice, field size in ha____or m^2_____
__Other __________ size in ha____or m^2_____
___________ size in ha____or m^2_____

D. How much rodenticide was used?

in Aman rice:
- __ kg of zinc phosphide bait
- __ # of wax blocks of Klerat
- __ # of 50 g bags Lanirat
- __ # of tablets of Phostoxin
- __ # of bags of Racumin tablets

around Homes:
- __ kg of zinc phosphide bait
- __ # of wax blocks of Klerat
- __ # of 50 g bags Lanirat
- __ # of tablets of Phostoxin
- __ # of bags of Racumin tablets

6. Other rodent control methods used?

in the Home
- __ Traps
- __ Flooding burrows
- __ Digging burrows
- __ Electric devices
- __ Burrow fumigation
- __ Other, describe____________

in the Fields
- __ Traps
- __ Flooding burrows
- __ Digging burrows
- __ Electric devices
- __ Burrow fumigation
- __ Other, describe____________

7. Conduct an assessment of the number of active rodent burrows in this farmers fields:

Crop(s)	Size, see 5.C above	No. Active Rodent Burrows	Notes

SURVEY FORM FOR SELECTED PESTICIDE DEALERS: The following is a draft form presented here for review, comment and improvement.

DISTRICT___________________________
UPAZILA___________________________
BLOCK_____________________________
DATE________________
INTERVIEWER Name______________________
DEALER Name__________________________
Village______________________

Did you know about the October Rodent Control Campaign? Yes No

Did you increase stocks of rodenticides in your store prior to the campaign? Yes No

What rodenticide products do you sell?
__Zinc phosphide, Brand Name?_______________%Conc.____
__Klerat (brodifacoum)
__Lanirat (bromadiolone)
__Phostoxin (aluminum phosphide)
__Racumin (coumatetralyl)
__Other

What products did you sell during the 2-week rodent campaign?
__Zinc phosphide, Brand Name?_______________%Conc.____
__Klerat (brodifacoum)
__Lanirat (bromadiolone)
__Phostoxin (aluminum phosphide)
__Racumin (coumatetralyl)
__Other

Zinc phosphide products purchased for bioassay
Assigned Number_________ Brand name__________________________
Concentration________

OTHER ORGANIZATIONS? Simply ask what rodent control activities, if any, were done by the local: Bangladesh Railways, Bangladesh Roads and Highways Department, Bangladesh Water Development Board, L.G.R.D. (Upazila Parishad), Forest Department, and NGO's.

SUMMARIZING DATA FROM THE QUESTIONNAIRES

From the Farmers Survey Form, tabulate the data first for each block, then each Upazila, then each district, and finally for all 16 districts.

QUESTION

1. Awareness
    - Yes
    - No
    - Total
2. By Block Supervisor
    - Yes
    - No
    - Total
3. Contact Farmer
    - Yes
    - No
    - Total
4. Control
    - Yes
    - No
    - Total

    A. Methods
    - Baiting
    - Other
    - Total

    B. Reason
    - No problem
    - No time
    - Didn't know how
    - No money
    - No rodenticide
    - Other
    - Total
5. A. Rodenticides Used
    - Zinc phosphide
    - Klerat
    - Lanirat
    - Phostoxin
    - Racumin
    - Other
    - Total

    B. Where used
    - Home
        - Burrow
        - Bait container
        - Other

- Fields
  - Burrow
  - Bait container
  - Other
- Other
  - Burrow
  - Bait container
  - Other

C. Crops
   - Aman rice
   - Other

D. Quantity used
   - Aman rice
     - Kg ZnP
     - Kg Klerat blocks
     - Kg Lanirat
     - Kg Phostoxin tablets
     - Kg Racumin
     - Kg Other
   - Other crops
     - Kg ZnP
     - Kg Klerat blocks
     - Kg Lanirat
     - Kg Phostoxin tablets
     - Kg Racumin
     - Kg Other
   - Around home
     - Kg ZnP
     - Kg Klerat blocks
     - Kg Lanirat
     - Kg Phostoxin tablets
     - Kg Racumin
     - Kg Other

6. Other methods used
   - Home
     - Traps
     - Flooding burrows
     - Digging burrows
     - Electric devices
     - Fumigation
     - Other
   - Field
     - Traps
     - Flooding burrows
     - Digging burrows
     - Electric devices
     - Fumigation
     - Other
7. Rodent burrows/ha
   - Aman rice
   - Other

AMOUNT OF CROP SAVED

Estimate from the reduction of rodent burrows (the difference between the number of burrows in fields that were baited and those that were not) how much grain was saved by those farmers who used the rodenticide properly in aman rice and other crops surveyed. Base this on known estimates of losses from an active burrow in aman rice and other crops surveyed. The separate, DAE damage assessment will have actual cut tiller data which may be used for comparison and/or adjustment of the estimate based on active rodent burrows.

EVALUATE WHEAT IN MARCH?

Since the strategy used will also reduce damage to wheat, a follow-up survey that counts the number of active rodent burrows in maturing wheat during March should be done. If the same farmers and their fields are surveyed, then only the rodent burrow count will need to be done; otherwise a new survey form will have to be completed in order to evaluate effectiveness of the baiting in October 1991.

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APPENDIX II

1991-1993 Bangladesh Vertebrate Pest Project Consultancy Schedule

Denver Wildlife Research Center

YEAR	MONTH	CONSULTANCY (TDY)	
		NO.	DWRC STAFFING
1991	OCTOBER	1	RODENT CONTROL SPECIALIST (L. Fiedler)
	NOVEMBER		
	DECEMBER		
1992	JANUARY	2	STATISTICIAN (D. Saltz)
	FEBRUARY	3	PREDATOR CONTROL SPECIALIST (name needed)
	MARCH		
	APRIL	4	PROJECT ADMINISTRATOR, BIRD CONTROL SPECIALIST (R. Bruggers)
	MAY	5	RODENT CONTROL SPECIALIST (J. Brooks)
	JUNE	6	EXTENSION SPECIALIST (J. Jackson or R. Schmidt)
	JULY		
	AUGUST		
	SEPTEMBER		
	OCTOBER		
	NOVEMBER	7	PROJECT ADMINISTRATOR, BIRD CONTROL SPECIALIST (R. Bruggers)
	DECEMBER		
1993	JANUARY	8	RODENT CONTROL SPECIALIST (L. Fiedler)
	FEBRUARY	9	PREDATOR CONTROL SPECIALIST (M. Jaeger)
	MARCH		
	APRIL	10	RESEARCH REVIEWER AND EVALUATOR (W. Jackson)
	MAY	11	PROJECT ADMINISTRATOR (R. Bruggers)
	JUNE		Project officially closes

DESCRIPTION OF EACH CONSULTANCY (TDY)

1
DWRC STAFFING: Rodent Control Specialist
TIME PERIOD: October 28 - November 26, 1991
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Prior to all others
DURATION: One month
FOCUS: Evaluation of National Rodent Control Campaign and Program Planning
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute and the Department of Agricultural Extension with:

- Developing a plan for evaluating the 1991 National Rodent Control Campaign
- Planning research and training activities for 1991-1992
- Planning project administration of DWRC TDY's to support VPS research and extension-related activities
- Review data, manuscripts, theses, and reports from 1990-1991 work

2
DWRC STAFFING: Statistician
TIME PERIOD: January 15 - February 8, 1992
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Any time prior to the rodent control specialist TDY scheduled for May-June 1991 and the extension specialist TDY scheduled for June 1992
DURATION: Three weeks
FOCUS: Statistics
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute and the Department of Agricultural Extension by:

- Renewing the SAS program software expiration date, upgrading the MS/DOS operating system to 5.0 and the Wordperfect word processing software to 5.1, and providing access to the Hard Disk Management software which is now inaccessible, on the IBM/PC computer system
- Establishing standard operating procedures for data entry and analysis
- Reviewing data from the evaluation of the 1991 National Rodent Control Campaign and recommending appropriate changes for future evaluations
- Reviewing research data from 1991 and research proposals for 1992 studies on rodents, birds and predators and recommending appropriate sampling and analyzing procedures
- Reviewing the 1991 DAE country-wide sampling scheme for assessing rodent damage in aman rice and recommending appropriate improvements
- Advising on other statistical problems encountered in wildlife research

3
DWRC STAFFING: Predator Specialist
TIME PERIOD: February 1992
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: January good, March OK but only as a last choice
DURATION: One month
FOCUS: Predator research program
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute and the Department of Agricultural Extension with:

- Reviewing progress of 1991-1992 predator research on jackals, particularly damage assessment in sugarcane
- Advising on enclosure studies designed to measure the predator capacity of jackals and jungle cats on rodents
- Reviewing draft manuscripts on jackal research
- Planning a research program for 1992-1993

4
DWRC STAFFING: Chief, International Programs Research Section
TIME PERIOD: April 1992
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Sooner, but not any later
DURATION: Three weeks
FOCUS: Project administration, FY 1993 planning, and bird research
SCOPE OF WORK: Assist the Office of Food and Agriculture/USAID, the Vertebrate Pest Section/Bangladesh Agricultural Research Institute, the Bangladesh Agricultural Research Council, the Department of Agricultural Extension, and other appropriate organizations on project implementation, administration, and planning with:

- Reviewing 1991-1992 project accomplishments
- Reviewing budget and finance
- Reviewing equipment, training, and documentation needs
- Reviewing 1991-1992 bird research, training staff in new bird research techniques, and planning a bird research program for 1992-1993

5
DWRC STAFFING: Rodent Control Specialist
TIME PERIOD: May-June, 1992
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Sooner but not later; should be after the Statistician TDY scheduled January-February 1992, and overlap with the Extension Specialist scheduled for June 1992
DURATION: One month
FOCUS: 1992 National Rodent Control Campaign Planning
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute and the Department of Agricultural Extension with:

- Developing and improving the strategy used to implement the National Rodent Control Campaign
- Planning the 1992 National Rodent Control Campaign
- Evaluating the quality, availability and cost of rodenticides in Bangladesh
- Strengthening the postharvest component of the National Rodent Control Campaign

6

DWRC STAFFING: Extension Specialist
TIME PERIOD: June 1992
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Sooner but not later; should be after Statistician TDY scheduled for January-February 1992 and overlap with the Rodent Specialist TDY scheduled for May-June 1992
DURATION: Three weeks
FOCUS: Extension of rodent control technology
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute and the Department of Agricultural Extension with:

- Reviewing the results of the 1991 National Rodent Control Campaign evaluation and suggestions from the Statistician TDY (January 1992) and the Rodent Specialist TDY (May-June 1992) and recommending improvements for the 1992 Campaign
- Reviewing the extension surveys of selected farmers on rodent control participation, adoption, knowledge, and training
- Evaluating the DAE training to extension supervisors and farmers including instructional materials
- Planning for the 1992 National Rodent Control Campaign

7

DWRC STAFFING: Chief, International Programs Research Section
TIME PERIOD: November 1992
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: October or December, 1992
DURATION: Three weeks
FOCUS: Project administration and bird research
SCOPE OF WORK: Assist the Office of Food and Agriculture/USAID, the Vertebrate Pest Section/Bangladesh Agricultural Research Institute, the Bangladesh Agricultural Research Council, the Department of Agricultural Extension, and other appropriate organizations on project implementation, administration, and planning with:

- Reviewing 1992 project accomplishments
- Reviewing budget and finance
- Reviewing equipment, training, facility, and documentation needs
- Reviewing progress of 1991-1992 bird research, training staff in new bird research techniques, and planning a research program for 1992-1993
- Reviewing the status of extension of rodent control technology

8

DWRC STAFFING: Rodent Control Specialist
TIME PERIOD: January 15-February 15, 1993
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Later but not sooner; other TDY's not affected by this one
DURATION: One month
FOCUS: National Rodent Control Campaigns
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute and the Department of Agricultural Extension with:

- Preparing a final report on the results and recommendations from the evaluations and monitoring of the National Rodent Control Program

-Organizing a forum to discuss the findings and recommendations
-Planning for publication of the findings and recommendations

9
DWRC STAFFING: Predator Control Specialist
TIME PERIOD: February 1993
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: January good, March OK, but only as a last choice
DURATION: One month
FOCUS: Predator research program
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute with an in-depth review of research conducted from 1991-1993 to include:
-Analyzing and interpreting data
-Instructing on the use and application of new methodologies
-Making general recommendations to BARI and BARC on the need for predator control, training, and additional research
-Planning for reporting and publishing of findings

10
DWRC STAFFING: Research Scientist
TIME PERIOD: April-May 1993
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: Sooner, but only if necessary
DURATION: Three weeks
FOCUS: Informal project research evaluation
SCOPE OF WORK: Assist the Vertebrate Pest Section/Bangladesh Agricultural Research Institute with:
-Reviewing vertebrate pest research conducted from 1991-1993
-Recommending future research needs in areas of rodents, birds, and predators in order to develop and improve IPM strategies to reduce preharvest and postharvest losses

11
DWRC STAFFING: Chief, International Programs Research Section
TIME PERIOD: May 1993
ALTERNATIVE TIME PERIODS RELATIVE TO OTHER TDY'S: None
DURATION: Two weeks
FOCUS: Close out project
SCOPE OF WORK: Assist the Office of Food and Agriculture/USAID, the Vertebrate Pest Section/Bangladesh Agricultural Research Institute, the Bangladesh Agricultural Research Council, the Department of Agricultural Extension, and other appropriate organizations in closing out the project with:
-Preparing a final report
-Establishing a long-term working relationship with VPS/BARI

DRAFT

Consultant's Report*

BIRD PESTS IN ARGENTINA AND URUGUAY

Marking Techniques

December 9-20, 1991

Richard L. Bruggers
Wildlife Biologist/Chief
International Programs Research Section
Denver Wildlife Research Center
Animal and Plant Health Inspection Service
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Unpublished Report Prepared for the United Nations
Food and Agriculture Organization

March 2, 1992

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ITINERARY

Date	Location	Activity
Dec 9-10	Denver, Colorado, to Montevideo, Uruguay	Traveled
Dec 10-12	Montevideo	Conducted briefings and had general discussion with Ms. Ethel Rodriguez, Ms. Maria Elena Zaccagnini, and other project consultants (Drs. Michael Jaeger and Robert Clark) regarding baiting methods and strategies, marking techniques, and bird pest management
Dec 13	Uruguay	Traveled in Uruguay, and visited a former parakeet nesting colony near Valdense and dove roosts at Passo Beatrice and Cerro Mullero
Dec 14	Uruguay to Colon, Argentina, and Paraná, Argentina	Traveled and visited parakeet colony in the Párque y Reserva Nacional El Palmár
Dec 15-18	Paraná	Demonstrated and discussed technique of marking doves with leg streamers, fluorescent paint particles and radiotelemetry, visited a dove roost at Las Cuevas, and assisted in a pilot demonstration of CPT/toxic grease on parakeets
Dec 19	Paraná to Buenos Aires, Argentina	Traveled; en route observed morning departure of doves from the Las Cuevas roost, and drove by the location of another dove roost. Briefed Ing. Agr. Diana Guilleń, project counterpart, and personnel at the Buenos Aires National Institute of Agricultural Technology (INTA) on consultancy observations and discussed potential future cooperation between INTA and the Denver Wildlife Research Center (DWRC)
Dec 20	Buenos Aires, Argentina, to Denver, Colorado	Traveled

TERMINUS DE REFERENCIA
[TERMS OF REFERENCE]

Consultor internacional especialista en técnicas de marcado masivo en aves
[(International consultant specializing in techniques for mass-marking birds]

Duración: 2 semanas [Duration: 2 weeks]

Lugar de destino: **Salto, Uruguay. Area binacional de Salto Grande**
[Location: Salto, Uruguay--The binational area (Argentina and Uruguay) of the Department of Salto Grande]

Actividades a realizar: [Activities]

1 - **Analizar la información y documentación existente en el área acerca de la problemática en la región, sobre biologia de las poblaciones de aves plaga de la agricultura (palomas - cotorras).**
[Analyze existing information and documentation available on the problems caused by birds to agriculture in the study area (doves and parakeets).]

2 - **Proponer las necesidades de información necesaria a efectos de diagnosticar los movimientos de la paloma median *Zenaida auriculata* mediante la utilización de técnicas de marcado en el area binacional.**
[Discuss methods for marking doves so to permit determining their movements in the binational area (Argentina and Uruguay).]

3 - **Proponer y participar en la elaboración de información y documentación que sea necesaria para realizar un diagnóstico lo mas representativo posible sobre los impactos negativos de las aves plaga.**
[Participate in documenting the negative impact birds (doves and parakeets) have on agriculture.]

4 - **Realizar visitas de reconocimiento y diagnóstico en campo, en las áreas problema en Argentina y Uruguay.**
[Visit field sites in Argentina and Uruguay to be familiar with the problems caused by birds.]

5 - **El eaborar el componente de técnicas de marcado masivo de aves plaga del programa binacional de manejo integrado de aves plaga.**
[Develop the components and technique for mass-marking pest species of birds in the binational program.]

6 - **Colaborar con el responsable del proyecto, el especiatista en formulación de proyectos y con los consultores del proyecto, en la elaboración del eventual anteproyecto de inversión sobre manejo integrado de aves plaga.**
[Work with others associated with the project (specialists and consultants) to help formulate a viable control program for future implementation.]

7 - **Participar en acciones de capacitación sobre técnicas de marcado masivo en aves plaga de la agricultura.**
[Participate in mass-marking pest species of birds.]

8 - **Preparar un informe técnico, con las observaciones, conclusiones y recomendaciones para <u>asegurar</u> que las técnicas de marcado masivo puedan llevarse a la práctica adecuadamente durante la realización del programa de manejo integrado de aves plaga.**
[Prepare a technical report with observations, conclusions, and recommendations for future use of mass-marking techniques.]

SUMMARY

The principal objective of this consultancy was to determine the potential usefulness of different marking techniques (e.g., mass-marking and radiotelemetry) in research on Eared Doves (*Zenaida auriculata*) and Monk Parakeets (*Myiopsitta monachus*) in Argentina and Uruguay. Based on field observations and discussions in each country, these techniques would seem to have great applicability in studies of foraging behavior relative to damage assessments, roost interchange relative to developing a baiting strategy, and nontarget (raptors) and environmental impacts relative to improving control methods. These kinds of studies, however, can require considerable logistical input so they need to have clearly defined hypotheses to achieve maximum results and need to be developed within the context of a longer term applied research project.

ACCOMPLISHMENTS

The short duration of this consultancy did not permit accomplishing all items in the Terms of Reference. Some items, such as numbers 5, 6, and 7, will need to be specifically addressed in additional consultancies or, more preferably, in a long-term, follow-on, applied bird pest management project. It was, therefore, agreed that the most advantageous use of time would be to look at birds and roosts relative to the usefulness of a variety of marking techniques.

The main accomplishments in Uruguay consisted of (a) clearing research chemicals from customs, (b) discussing the overall bird pest situation and trying to identify with project counterparts and other visiting consultants the situations in which different marking techniques could be useful, (c) assisting in identifying equipment needs, and (d) visiting one traditional parakeet nesting colony and two dove roosting sites.

In Argentina, (a) site visits were made, and discussions were held concerning appropriate methods to mark birds or monitor their movements relative to three situations of concern:

- daily parakeet movements from the Párque y Reserva Nacional El Palmár to surrounding agriculture fields,
- daily dove movements from a roost at Las Cuevas into surrounding sunflower and corn fields, and
- implementation of any toxicant baiting program for dove control;

(b) demonstrations were videotaped of applying the mass-marking technique and leg streamers to doves and applying CPT/gel formulations to parakeets that were available at INTA in Paraná; and (c) briefings were held with Ing. Agr. Diana Guilleń, Direccion de Agricultura, on consultancy accomplishments and with Dr. Jorge Amaya, Vice President, and Dr. Blas F. Bravo, Director of International Relations, INTA, in Buenos Aires, regarding the current consultancies and potential cooperation between INTA and DWRC.

MARKING AND MONITORING TECHNIQUES

Several techniques exist for marking birds. These include mass-marking with fluorescent paint particles, radiotelemetry, and plastic leg streamers. The decision of which technique to use depends on the specific research question being asked, the species involved and its behavior pattern, the timeframe of the study, and the logistical requirements to implement the study. The following discussions are directed at marking techniques for Eared Doves.

Mass-Marking

Mass-marking has proven very useful to mark birds in nesting or roosting aggregations. This technique is compatible with other marking methods, yet it can permit marking literally hundreds of thousands of birds during one evening at relatively low cost using standard spray equipment and procedures. It also offers the possibility of obtaining a reasonable number of marked recaptures, depending on the specific situation. Birds can be collected in mist-nets or after control operations and examined under ultraviolet (UV) light for the presence of fluorescent particles.

The mass-marking technique uses particles that fluoresce when exposed to long-wave (360 nm) UV light. The highly fluorescent particles are not diluted or quenched on a feather; small flecks of markers, as minute as 10 μm in diameter (slightly larger than a red blood cell), can be detected on feathers in UV light with the unaided eye.

The commercially available markers are amorphous, transparent organic resin particles that contain dyes which are capable of fluorescing while in a solid state solution. Most particles are 3.5-4.0 μm in size, but they range from <1.0 μm to 50.0 μm; 95 percent of the particles fall between 2 and 13 μm. Ten colors are available. The particles are essentially nontoxic; the oral LD_{50} in rats is >16 g/kg.

The currently used marker spray formulation was developed to be compatible with avicide application equipment and techniques used in Africa for Red-billed Quelea *Quelea quelea*. The components of the formulation are, by volume, 95 parts diesel fuel and 5 parts boiled linseed oil plus, by weight, 2 parts particle markers. Thus, a 100-L spray load would contain 95 L diesel fuel, 5 L boiled linseed oil, and 2 kg particle marker. Initial examination of marker wear rates on quelea indicated that the wings held markers better than other body parts. Additional examination of wear rates in Red-winged Blackbirds determined that wing collection was the most efficient means of detecting marked birds.

A variety of aircraft, spray systems, and ground-spraying equipment have been used to mark quelea. Both fixed-wing (De Havilland Beaver) and rotor-wing (Bell Jet Ranger 206) aircraft have been successfully used to mass-mark birds. They have been fitted with spray systems like

Micronair®[1] (AU 3000, AU 4000), or similar rotating-disc designs with two sprayers per aircraft, or a boom and nozzle system. Droplets with a volume median diameter (vmd) of 100 μm seem to mark birds well, but marking should still be successful with droplets in the range of 40-150 μm vmd. Droplets outside this range could be too fine to leave marks or too large to have a chance of impacting on a bird, either because they are too few or they do not remain airborne long enough. As a general rule, a boom- and nozzle-type spray system will require a greater volume of spray liquid than a rotating-disc spray system to mark the same number of birds.

The concept of mass-marking using ground application techniques is basically the same as for aerial application--bringing a cloud of droplets into contact with birds. During aerial spraying, spray both descends and drifts, while during ground spraying, spray movement relies mainly on wind drift with a slight amount of vertical movement. This difference in application requires that the ground-generated spray clouds have droplet diameters sufficiently small to hang in the air, as the wind drifts the spray cloud into the birds or the birds fly through it. Droplets in the 40- to 60-μm range can be transported in light winds (2-5 m/sec) and will mark birds well; droplets <40 μm are carried in the slightest breeze (< m/sec), while droplets >60 μm will drop to the ground quickly unless the wind speed exceeds 5 m/sec. Therefore, a spray cloud of droplets from ground sprayers with a vmd of 40 μm should provide acceptable marking under a variety of wind conditions. Stationary and moving ground spraying systems are commercially available. More than one unit may be required to obtain proper marking coverage of a site, considering the size of the roost or colony and the wind conditions.

When marking is conducted in the context of a well-defined hypothesis and adequate logistical support is available to permit conscientious and thorough postspray bird collections, marked birds usually have been found and useful information has resulted. In general, mass-marking appears to be particularly valuable when it is of interest to know when and where bird aggregations are likely to threaten cereal crops. Such information is necessary for making bird control selective and focused where it can be of greatest benefit.

Radiotelemetry

Radiotelemetry should be considered as part of several different studies that will need to be implemented in any future project. The technique has applicability to locating dove roosts, identifying interchange of birds among roosts, determining feeding distances of birds from roosts, determining the impact of any dove baiting trials on raptors and other potential predators, and perhaps evaluating the effectiveness of crop protection efforts.

From the discussion, it appeared that most dove roosts along the Río Paraná in Argentina and the Río Negro and Río Uruguay in Uruguay appear to be historically traditional and known. Others may, however, exist. If this

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

is suspected, birds could be trapped in fields, equipped with radio transmitters, and followed to their roosts. Such an approach permits either locating new or confirming existing roosts, and it provides a knowledge that birds from particular roosts are damaging crops. Alternatively, birds can be equipped in roosts and tracked to their feeding sites to provide data necessary to designing a control baiting program. Baiting for doves could be useful only if one knows that the same birds are feeding in an area for several days. The technique of radiotelemetry can help provide this information. If the effectiveness of baiting is to be evaluated, both doves that feed on baits and any raptors in the baited area need to be equipped with transmitters to first determine the area over which affected doves disperse and die and the potential impact these mortalities could have on the raptor population. Any baiting near the dove roost at Las Cuevas, Argentina, would have an adverse impact on the several hundred raptors we saw in the immediate area, assuming they eat affected birds.

Equipment, such as receivers and various types of antennas and radio transmitters, needed to conduct these kinds of studies for both doves and raptors, is commercially available. The quantity and type of each needed item would depend on the objectives of the study being designed. Within this context, a number of variables need to be considered when designing a particular study that involves radiotelemetry, including among others,

- Impact of the transmitter package on the bird's behavior
- Battery life vs. aerial or ground tracking reception distance needed
- Need for a mortality circuit included with the transmitter
- Duration of the study
- Attachment technique
- Need for, and availability of, aerial tracking capability

The roost that we visited at Las Cuevas, Argentina (and presumably similar roosts in Uruguay), would lend itself to many kinds of important, applied management radiotelemetry studies. These studies should be prioritized and designed very early on in any long-term, follow-on project relative to the overall objectives of such a project.

Another marking technique that could be used in baiting trials is the incorporation of metal flakes into the baits. These tiny flakes adhere to the intestinal tracts of the birds. Again, collecting stations could be set up to look at any birds found dead in fields or perhaps shot by hunters. Such data would confirm acceptance of the baiting strategy and provide additional information as to how far birds might disperse after eating treated bait.

Use of Marking Methods in Uruguay and Argentina

Several studies related to improving dove management in Argentina and Uruguay would benefit from incorporating these marking techniques. At least four dove roosts/colonies exist along the Río Paraná. If any eventual selective baiting strategy in agricultural fields is to be implemented, it is necessary to know whether any interchange of birds from these roosts occurs and which roosts are the most important contributors of birds to agricultural damage. To get at this problem, birds in each roost could be sprayed with different colors of fluorescent paint (just prior to the dove hunting season) and then sampled at night in or as they return to the roosts. The hypothesis could be considerably narrowed to look at feeding patterns and distribution of birds from only one or two roosts as well. In both situations, hunters from the countryside surrounding the roosts could be encouraged to provide one wing of each dove shot to be examined for markers.

From what I saw at the Las Cuevas roost in Argentina, ground sprayers could be used to mark the birds. The roost was accessible by vehicle and the birds flew in low (3-5 m), seemingly along several corridors. The roost appeared too dense to try an aerial application, but the potential of that method of application could be evaluated in some pilot studies. The roost at Cerro Mullero, Uruguay, was likely more suitable to overall applications of the markers, as it was much less dense. However, as previously indicated, it did not have any birds at the time of our visit.

It would be very useful to inventory in detail the availability of either ground or aerial spraying equipment within each country either within the government, through private contractors, or on the commercial market so that equipment needed to conduct these studies can be identified at the time the studies are being designed.

Discussions also focused around determining some seasonal movements in both countries. In Argentina, there apparently is interest in determining if doves migrate between Entre Rios and Cordoba and between Cordoba and Chaco. It is thought that doves may move between roosts along the Río Salto, Uruguay, and Entre Rios, Argentina. These kinds of studies would appear to require enormous logistic support relative to spraying and sampling birds and, while certainly interesting, would provide useful information to an applied management project only if the seasonal migratory movements of birds from one area could be correlated to increased crop damage in another. Then, selective control might be justified of doves in roosts at one time of year that migrate and cause damage to crops in other areas at other times of the year. However, the opportunity to obtain meaningful results with this kind of study decreases due to the enormously large numbers of birds that would need to be marked, and the thousands that likely will need to be collected immediately after spraying throughout the countries. The markers also deteriorate over time, moult may occur, and group cohesion may prohibit finding marked birds later on if postmarking sampling is not sufficiently widespread. These kinds of variables can easily result in the problem of trying to interpret negative data. Therefore, I feel that the previously discussed movement and baiting impact studies should be given higher priority.

Monk Parakeet Movement Studies

The foraging patterns of parakeets to agricultural fields surrounding the Párque y Reserva Nacional El Palmár, in which they are protected, lends itself very nicely to the use of markers--such as radiotelemetry. The reported situations relative to fruit crop damage, which I did not observe, may also be suitable.

However, during this consultancy, project counterpart scientists repeatedly stressed that previously undertaken studies to mark parakeets with leg bands were unsuccessful due to birds always removing the bands and that they likely also would remove radio transmitter packages. This seems surprising considering that leg bands are commercially available for parrots and parakeets from numerous aviculture outlets. Likewise, with the strength of many new cloth, plastic, and other materials, I would think that some type of highly visible, leg streamer/leg-band combination could be improvised to mark individual birds. Retention trials could be conducted in an aviary, and field studies that optimize their use then could be designed.

I also think that the "success" and even potential adverse nontarget impact of any toxicant/grease formulations being used to control parakeets could be better understood using radio transmitters. Birds could be radio-equipped, their nests treated, and their posttreatment dispersal and/or movement and subsequent morality patterns determined. Again, aviary/laboratory studies would be needed to determine an attachment technique or transmitter design that parakeets would retain. Transmitter packages and attachment techniques may already be available as numerous studies on other parakeets, such as the Rose-ringed Parakeet (*Psittacula krameri*), and other members of the parrots and parakeet family have been conducted.

CONCLUSIONS

From what I observed and learned in Argentina, doves are not only an agricultural pest but also a unique resource, particularly in terms of their international appeal to hunters and the resulting income they generate to hunting guides and the landowners on whose estates they roost. Parakeets also seem to be appreciated in situations in which they do not cause damage. Clearly, much more time is needed to sort out many of the complexities of these birds and of other birds considered pests in both Argentina and Uruguay.

Applied, problem-oriented work is needed to (1) better define the impact of doves and parakeets on agriculture, (2) clarify the circumstances under which the various species of concern actually are pests, (3) determine the usefulness of control, (4) develop economical control techniques and a strategy that, when necessary, can be used with little or no adverse impact to nontarget wildlife and the environment. The various marking techniques available for birds should be able to help provide the data necessary to clarify these various situations.

These areas of concern do not need to proceed in a step-wise manner. For example, work on toxicants can be initiated while damage assessments are being undertaken. Yet a baiting strategy for doves does require some basic behavioral movement information to determine if it has any chance to succeed effectively and safely in an operational manner. However, the various studies needed must be clearly defined, organized in a problem-solving fashion, and fit into an overall implementation plan that will provide answers.

CONTACTS AND ACKNOWLEDGMENTS

This consultancy was very short and fast-paced. Its duration was determined by the short recruitment notice and the need to return to the United States before the Christmas holidays. Nonetheless, I greatly appreciate the opportunity to have participated and enjoyed working with Ms. Ethel Rodriguez and Ms. Maria Elena Zaccagnini in their countries after having been associated with them in Colorado. I also wish to express my appreciation to the many other individuals whom I met. I hope that the much needed, longer-term project does materialize.

Argentina

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DRAFT

CONSULTANT'S REPORT*

PRELIMINARY EVALUATION OF CPT/CPTH AS AN AVICIDE FOR USE IN ARGENTINA AND URUGUAY

December 9-20, 1991

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ABSTRACT

The efficacy of CPT-treated grease/gel formulations was tested on Monk Parakeets (*Myiopsitta monachus*). No mortalities resulted, suggesting that either the formulation was inappropriate or that parakeets are relatively insensitive to CPT. Further testing is needed to resolve the issue.

Preliminary observations of flocking and roosting behavior of Eared Doves (*Zenaida auriculata*) suggested that a control strategy with farmers independently treating their own fields with toxic baits is unlikely, in most situations, to effectively reduce damage by this species. Further study is needed to determine the most effective baiting strategy.

1. INTRODUCTION

This report describes the second visit to Argentina and Uruguay during 1991 to evaluate and recommend on the use of lethal methods to reduce bird damage. In the first report it was recommended that the avicide CPT (3-chloro-*p*-toluidine) and its hydrochloride salt CPTH (DRC-1339, Starlicide) be evaluated as follows on the three major bird pest groups:

- Doves and pigeons - CPTH-treated grain baits
- Parakeets - CPT-treated grease/gel applied to the nest entrance
- Blackbirds - CPTH-treated grain baits

The evaluation process includes:

- Testing the efficacy of the avicide in terms of lethal dosage and formulation; and
- Testing the efficacy of the strategy for applying the avicide formulation (e.g., baiting strategy) in terms of reducing crop damage

The principal objective of this second visit was to test for the efficacy of a CPT-treated grease/gel formulation applied externally on the feathers of parakeets. The general strategy for field use of this method of application was already known to be effective. The secondary objective was to observe dove feeding flocks and roosts in order to formulate hypotheses about the likely impact of different baiting strategies using CPTH-treated grain baits. CPTH-treated grain baits were already known to be highly effective against doves (*Zenaida* spp.), pigeons (*Columba* spp.), and blackbirds (*Agelaius* spp.) under laboratory conditions. However, it was not known whether the use of toxic baits in field conditions reduces damage caused by Eared Doves.

2. CPT EFFICACY--PARAKEETS

2.1 OBJECTIVE

- To test CPT-treated grease/gel formulations on parakeets in order to determine their general sensitivity to this avicide under conditions simulating those during control.

2.2 METHODS

- The test was conducted in Argentina, beginning in mid-December 1991. A total of 34 parakeets were captured near Cordoba and transferred to a large outdoor aviary at the National Institute of Agricultural Technology (Instituto Nacional de Technologia Agropecuaria [INTA]) research station near Paraná, Entre Rios.

- Parakeets were randomly assigned to the test groups listed in Table 1. Three concentrations of CPT (2, 4, and 6%) were tested in each of two formulations (silica gel and automobile grease). Approximately 1 g of a formulation was wiped onto the breast of each bird from where the bird could remove either the gel or grease with its bill while grooming. Automobile grease is the traditionally used carrier for avicides applied to the nest openings of parakeets. Silica gel (Syloid 244) with a vegetable oil (sunflower) base was tested as an alternative carrier for CPT. It degrades faster than automobile grease, and it should be more palatable to the parakeets. It was assumed that the birds would ingest the formulation in the process of trying to remove this tacky material from their feathers.

Table 1. CPT test design and results.

CPT formulation	*n*	$\bar{x}$ body weight (g)	Approx. dosage CPT[1] (mg/kg)	Mortality[2]
Control--silica gel	5	75.8	-	0/5
2% CPT--silica gel	5	71.6	279	0/5
4% CPT--silica gel	5	70.0	571	0/5
6% CPT--silica gel	5	71.0	845	0/5
Control--automobile grease	5	72.0	-	0/5
4% CPT--automobile grease	4	77.5	516	0/4
6% CPT--automobile grease	5	71.0	845	0/5

[1] In approximately 1 g of the formulation applied to the breast of each bird.
[2] After 2 weeks.

- Following treatment parakeets were released into the common aviary and checked twice daily for the next 2 weeks for mortalities.

2.3 RESULTS

- Immediately following treatment, parakeets were seen to groom their breast feathers. On the following day, a number of parakeets had removed the breast feathers where the treatment had been applied.

- None of the parakeets died during the 2-week posttreatment period (Table 1).

2.4 CONCLUSIONS AND RECOMMENDATIONS

- There are a number of possible explanations for these results:

  - Parakeets ingested the treatment formulations while grooming, but the CPT was ineffective at the dosage levels used here;

  - Parakeets did not ingest the treatment formulations while grooming, but they were able to remove and discard the tacky material; or

  - The CPT used in this experiment may possibly have degraded since it had been sitting on a laboratory shelf for more than a year.

- Either of the first two explanations seems the most likely. The issue can be resolved by another test in which the formulations are inserted directly into the birds' digestive systems by gavage. If satisfactory levels of mortality result, the problem is not the CPT *per se*, but rather the way that it was applied. We had assumed that ingestion was the principal mode of entry of avicides in a gel/grease formulation. Absorption through the skin, however, may be more important. Further testing with formulations designed for dermal absorption could resolve the issue. If no mortality results from the gavaging, the CPT used had either degraded or was ineffective at the dosages used here. If the later proves true, then an alternative to CPT should be sought.

3. BAITING STRATEGY--DOVES

3.1 PROBLEM DEFINITION

- CPTH-treated grain baits will effectively kill doves, pigeons, and blackbirds. The use of poisoned baits under field conditions, however, may not result in a reduction of damage. This method of control may be particularly problematical with the Eared Dove when the following occurs:

  - Doves originate daily from large roosting/nesting aggregations of the order of 100,000's to 1,000,000's of birds, and whose overall numbers are impractical and undesirable to reduce through baiting; and

   - Feeding flocks are small in size, have many fields of vulnerable crops to choose from, and tend to sample widely and not concentrate their feeding in few fields.

- CPTH poisoning does not stop damage immediately. Death usually occurs about 3 days' post-ingestion. Poisoning small flocks of doves in fields to which they may not regularly return, and to which new flocks will continue to come, will not reduce damage.

- Baiting of individual fields is more likely to be effective where the same feeding flocks tend to return daily to the same fields over a period of days exceeding the time it takes the avicide to kill a bird.

- Flocks tend to sample widely where vulnerable crops are widespread and, therefore, not to return to the same feeding sites.

- Baiting of staging areas (Jaeger and Bruggers, 1989) or daytime roost sites where feeding flocks regularly gather can more effectively reduce damage than baiting individual fields, particularly in areas where damage is intense and widespread. These sites tend to be more stable over days than feeding sites, be fewer in number, and contain much larger concentrations of birds.

- The tendency for Eared Doves to form flightlines (for a description of flightlines, see Jaeger and Bruggers, 1989), use staging areas, or form daytime roosts is not well-known.

3.2 OBJECTIVE

- The objective was to observe flocks of Eared Doves entering and departing a major roosting/nesting site when and where vulnerable crops were available nearby in order to determine whether flightlines or staging areas were used which could be incorporated into a baiting strategy that effectively reduces damage.

3.3 STUDY SITE

- Observations were made at the Las Cuevas dove roost located approximately 70 km south of Paraná along the east side of the floodplain of the Rio Paraná. Ripening sunflower fields were widely scattered in the general vicinity of this roost site. Nests with eggs or recently hatched nestlings were found.

3.4 RESULTS

- Doves were observed to return to this site over a 3- to 4-hour period in the evening and across a broad front of at least 4 km. A rough approximation of the numbers entering the roost was 2.5 million.

- There was no evidence of discrete flightlines or staging areas in either the morning departure from or the evening return to the

roosting/nesting site. Doves appeared to move in small flocks or individually.

3.5 CONCLUSIONS AND RECOMMENDATIONS

- These observations suggested that the doves scattered and fed over a large area and that baiting of individual fields, or feeding sites within large fields, was the only baiting strategy available at this time. This situation might have been different earlier when relatively few fields had matured and were vulnerable, and later when relatively few fields remained to be harvested.

- It has been suggested that a strategy of baiting individual fields or feeding sites within fields may not effectively reduce damage, particularly where it is widespread. Systematic observations of fields where damage is occurring should be undertaken to determine whether the same birds tend to return daily to a feeding site over a period long enough for poisoning to be beneficial. This can be done as follows:

  - Count the number of days that feeding flocks occur at a damage site. If flocks tend to return daily over a period of 4 or more days; then

  - Mark doves from feeding flocks with, e.g., colored leg streamers or radios, and determine if the same birds tend to return.

- If such studies indicate that baiting individual fields is unlikely to reduce damage, then alternatives to baiting should be sought, e.g., the use of frightening methods which can have an immediate effect on removing birds from a site.

4. ACKNOWLEDGMENTS

I would like to thank Messrs. Roger Bullard, Melvyn Garrison, Steven Greiner, Peter Johns, Jerry Roberts, and Peter Savarie of the Denver Wildlife Research Center for their assistance with the methods and materials needed for the CPT study. I would also like to thank Messrs. Richard Bruggers, John Cummings, and Peter Savarie for reviewing an earlier draft of this report.

I am especially grateful to Ms. Maria Elena Zaccagnini and Mr. Juan Carlos Sedrán in Argentina and Ms. Ethel Rodriquez in Uruguay for their assistance.

5. REFERENCES

Jaeger, M. M., and R. L. Bruggers. 1989. Flocking and seasonal movements of *Quelea quelea* and *Agelaius phoeniceus* in relation to crop damage. Pages 271-316 *in* G. E. Russell, editor, Agricultural Zoology Reviews, Vol. 3. Intercept, Ltd., Wimborne, Dorset, United Kingdom.

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[illegible] Many [illegible] rings [illegible]

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4. ACKNOWLEDGMENTS

I would like to thank Messrs. [illegible] Lloyd, [illegible] Green, [illegible] John S. Gerry [illegible] Sampson [illegible] WHITTIN[illegible] [illegible]

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Trip Report*

Morocco Locust Control Project

Effects of Experimental Applications of Malathion and Dichlorvos on Populations of Birds, Mammals, and Insects in Southern Morocco

January 17-February 28, 1992

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RESEARCH SUMMARY

During the 1986-1990 eruptions of desert locusts (*Schistocerca gregaria*) in Africa, over 4.5 million ha were treated with insecticides in Morocco. Insecticides are capable of killing most arthropods and thereby disrupt the community ecology of invertebrates and vertebrates on treated areas. Several organophosphate insecticides are capable of causing mortality in birds. The ecotoxicological risk of pesticide use in arid regions is virtually unknown. Since most knowledge on the hazard of insecticides has been developed in more temperate climatic zones, detailed field assessments are needed to ascertain the impact of insecticides in arid regions where locust control is undertaken.

In April 1990, DWRC began a cooperative project with AID/Rabat and the Moroccan Ministry of Agriculture's Plant Protection Department for research and training of Moroccan scientists (Table 1) to evaluate the impact of locust control pesticides on the environment and nontarget wildlife. The Project included two phases: (1) training Moroccan scientists in the concepts and methods of ecotoxicological studies, and (2) conducting studies of the environmental effects of malathion and dichlorvos, the two principal insecticides that had been used in Morocco's locust control campaigns.

Between May 1990 and October 1991, DWRC conducted six training sessions for Moroccan participants in ecotoxicological methods, methods of collecting animal and plant tissues for measurement of pesticide residues, chemical methods of residue measurement, statistical techniques, radiotelemetry, and field methods for determining the relative abundance of birds, mammals, and beneficial insects.

The second phase of this Project was to evaluate the effects of field applications of malathion and dichlorvos on birds, mammals, and beneficial insects. The study was originally planned for February and March 1991, but it had to be rescheduled for early 1992 due to travel restrictions created by the Persian Gulf crisis. Treatments were to be made to experimental plots where, most likely, locusts would not be present, but where adequate data might be obtained prior to treatments. In operational control, insecticides are usually applied onto swarms the day after the swarms are located in the field, which leaves inadequate time to collect pretreatment information.

Study objectives were:

1. Aerially apply malathion and dichlorvos to large experimental plots at rates and formulations used in locust control.

2. Treat plots in January and February when locust control was undertaken in the area.

3. Measure the numbers and/or activity of birds, mammals, and beneficial insects on study plots before and after treatments.

Table 1. Moroccan and American research teams.

Teams	Americans	Moroccans
Insects	P. Matteson	A. Baou A. El Fayq S. Ghaout A. Mouhim El Jaouani A. El Bakkouri
Bees	--------	L. Abail D. Aid Belarbi L. Zerhloul S. Merzouk
Birds	R. Bruggers J. Heisterberg	A. Aloui A. El Hani H. El Addami
Mammals	R. Curnow L. Fiedler J. McConnell	H. Arroub A. Ouzaouit B. Id Messaoud
Radiotelemetry	P. Hegdal J. Bourassa R. Johnson R. Phillips	O. Alhillali M. Ramzi
Cholinesterase	J. Keith	A. Akchati M. Benchra S. Sahil
Residues	J. Gillis	M. Tarhy A. Daia A. Falaq
Searches	J. Keith	Local residents
Deposits	--------	A. Afrass S. Lagnaoui
Data Entry	R. Engeman L. Fiedler R. Curnow R. Johnson	All participants

4. Determine treatment effects on the food habits and food availability of vertebrates.

5. Use radiotelemetry to monitor mortality and movements from plots by vertebrates in response to treatments.

6. Measure spray deposits on plots, initial residue levels, and their persistence in soil and vegetation.

7. Search plots for vertebrate mortality, and determine exposure of selected vertebrate species through measurement of brain cholinesterase.

Teams of U.S. scientists cooperated with Moroccan biologists during each phase of this study to evaluate malathion and dichlorvos applications to large experimental plots in the desert of southern Morocco. Nine 3-km^2 plots were used; three were controls, while a helicopter sprayed three with malathion (750 g/ha) and three with dichlorvos (200 g/ha). Field investigations were scheduled during the 5 weeks between January 20 and February 23, 1992. This schedule allowed 2 weeks before and after treatment for measurement of abundance, foods, movements, and cholinesterase levels in animals. The middle week was for treatment of plots, searches for dead animals, and initial sampling for residue analyses. Collection of data on the abundance of birds, mammals, and insects was proposed for 9 days before treatments and 9 days following treatments.

However, weather and problems with the helicopter and spray apparatus caused delays in treatments and in the timing of posttreatment data collections. Strong, easterly winds that began the night of January 31 and continued until February 4 delayed the arrival of the helicopter. Morning fog often prevented spraying early in the day, while falling humidity, increasing temperatures, and convection currents often halted spraying well before noon. Electrical problems with the helicopter, failure of the spray pump, and breakage of spray pods (orifices and nozzles) often caused delays when weather was satisfactory.

Except for one malathion plot, very little of the insecticide reached the ground on treated plots. Malathion residues in soil decreased 85-90 percent after 1 week. Residues of malathion on vegetation were low and only trace amounts of dichlorvos were recovered from either soil or plants. Inhibition of cholinesterase was found only in brains of Thekla Larks (*Galerida theklae*) on malathion plots; but levels decreased only 18 percent, which was not sufficient to suggest serious impairment. No apparent mortality of birds and mammals occurred and no important, significant effects were found on numbers or activity of birds and mammals. Rodent activity was reduced 36 percent on malathion plots. Rodent catch in traps decreased 26 and 32 percent under malathion and dichlorvos treatments, respectively, while it increased 33 percent on control plots. However, these changes were not statistically significant. Malathion had real effects on mortality in bees, the occurrence of ants, the abundance of orthopterans, and apparently on numbers of one species of beetle. Dichlorvos did not have severe effects on insects, but reduced the numbers of bees entering hives and the abundance of beetles on plots. Bird and mammal food habits were not affected, except that ants largely disappeared from diets of birds on malathion plots. More intense effects of both insecticides undoubtedly would have occurred if treatments had been effectively applied to experimental plots. Nonetheless, these findings may allow for some re-evaluation of dosage recommendations in the future. This, in turn, may have an effect on the next locust infestation in Morocco and result in a positive benefit to Morocco's agricultural production. The findings from the Morocco study may also find application in the more arid regions of the United States and the rest of the world and benefit food production worldwide.

Results obtained in this study were compromised by inadequate treatment of plots with insecticides. This is regrettable as the scientific quality of sampling data, and the industry and efforts of the scientists gathering data were of the highest quality. However, the ultimate purpose of this project and of the field research was to prepare Moroccan scientists to conduct future ecotoxicology studies, and based on their performance in this study, they are well-prepared to conduct further evaluations of pesticide effects on wildlife and the environment.

CONTRIBUTORS

Many individuals and organizations participated in this enormously complicated research phase of this Project. I would just like to mention a few; others have been acknowledged in previous trip reports.

Administrative support for this project and the research conducted in 1992 was provided by Generale H. Benslimane (Coordonnateur National de la Lutte Antiacridienne, Gendarmerie Royale), A. Arifi (DPVCTRF, Ministry of Agriculture and Agrarian Reform), T. Ben Halima (Centre National de la Lutte Antiacridienne, Ministry of the Interior), Joe Kitts (USAID, Morocco), and Richard Bruggers (Denver Wildlife Research Center, USDA).

James Keith, H. El Addami, and M. Charhbili selected the study area. John McConnell and a survey team from the Direction Provinciale d'Agriculture, Guelmim, located study plots and marked boundaries of plots and sampling areas. John McConnell and workers from the Centre National de la Lutte Antiacridienne established the tent camp at which biologists and chemists were lodged. The workers provided all meals and other necessities and coordinated purchases with John McConnell, Joe Kitts, and A. Muhim.

Michael Avery, John Gillis, James Keith, Lawrence Kolz, Keith LaVoie, Patricia Matteson, and Robert Phillips provided field training in research methods, especially during training sessions at Aït Baha in October 1990 and October 1991. In cooperation with Moroccan counterparts, they developed and tested most methods used in this research. Richard Engeman advised on the experimental design, sampling, and statistical analyses.

The Centre National de la Lutte Antiacridienne supplied pesticides and a team to load material into the helicopter. The Poste de Commandement Central (Gendarmerie Royale) provided the helicopter and a pilot and mechanic to apply insecticides.

Participants collected data during the study period. John McConnell obtained historic weather records, and in addition to his other duties, he worked on a rodent team. Michael Avery designed methodology for plant inventory and collected data on four plots in October 1991; measurements on other plots were taken by James Keith and A. El Hani in January 1992. Richard Engeman advised on sampling strategies and data entry into laptop computers. He later provided statistical analysis of field data.

American Participants in the 1992 Morocco Locust Control Project

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TRIP REPORT*

ASSESSMENT OF SAHELIAN RODENT POPULATIONS IN SENEGAL

March 11-28, 1992

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ITINERARY

Date	Location	Activity
Mar 11-12	Denver, Colorado, to Dakar, Senegal	Traveled
Mar 12-17	Dakar	Consulted with U.S. Agency for International Development (USAID), Food and Agriculture Organization of the United Nations (FAO), Department of Crop Protection, and made in-country research arrangements
Mar 17-18	Richard Toll, Dagana	Assessed rodent populations and interviewed farmers
Mar 19	Matam	
Mar 20	Podor	
Mar 21	St. Louis	
Mar 22	Bambey, Thies	
Mar 23	Kaolack, Kaffrine	
Mar 24-27	Dakar	Debriefed USAID officials, wrote trip report, and met with personnel from the Department of Crop Protection and Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM)
Mar 27-28	Dakar, Senegal, to Denver, Colorado	Traveled

SUMMARY

Rodent population assessments were conducted at five sites in the Senegal River Valley (St. Louis, Richard Toll, Dagana, Podor, and Matam) and at four sites in the peanut basin area (near Thies, Bambey, Diourbel, and Kaffrine). Samples provided data on the relative densities of rodent populations in available crop and noncrop habitats. The dominant rodent species in the valley was the unstriped grass rat (*Arvicanthis niloticus*), followed by one species of the multimammate rat complex (*Mastomys* [=*Praomys*] *huberti*.) Rodent densities were higher than normal in irrigated vegetable plots near Dagana and St. Louis and in wet ditches in fallow rice fields near Richard Toll. Burrow counts along 100-m transects agreed with the trapping data. Rodent densities were low in the peanut basin at all sites, based both upon trapping and burrow counting efforts. Both *Arvicanthis* and *Mastomys* showed evidence of a strong breeding effort just 2 to 3 months ago: 79% of 14 captured *Mastomys* were sexual immatures, and 49% of 37 *Arvicanthis* were immatures. Two of 4 adult female *Arvicanthis* were pregnant, indicating the normal post-rainy season breeding effort had been prolonged. These two pest rodent species could reach outbreak populations if the 1992 and 1993 rainy seasons are normal or above. Data from previous French studies in Senegal indicate that two rainy seasons are needed for rodents to reach outbreak proportions (Hubert and Adam, 1985; Poulet, 1980 and 1985). The 30-year average for rainfall indicates precipitation has been below normal in the preceding 2 years. The in-country capabilities for monitoring Sahelian rodent populations to network with a regional West African monitoring program are excellent within the Department of Crop Protection/Ministry of Rural Development. A cadre of trained and interested personnel in this agency is available throughout the country, needing only some minor equipment and supplies, training, and a monitoring protocol for setting up a rodent monitoring program.

OBJECTIVES

The objectives of this TDY visit were to (1) monitor the current density of rodents at several sites in the Senegal River Valley and in the peanut/millet rainfed agricultural areas near Thies, Diourbel and Kaolack; (2) determine if there is in-country capability to set up Sahelian rodent population monitoring sites in Senegal to network with a possible regional West African monitoring program; and (3) meet with appropriate USAID, FAO, Senegal Ministry of Rural Development/Department of Plant Protection, and ORSTOM personnel on the rodent situation in Senegal. All objectives were met.

BACKGROUND

Rodent outbreaks have periodically occurred in Sahelian Africa for centuries. Following a period of drought, Senegal had increased rains in 1985 and 1986; this resulted in very high rodent populations in 1986 and 1987, prompting the Senegal Ministry of Rural Development to request of donors additional funding for rodenticides and related materials in February 1987. A team of DWRC and FAO biologists visited Senegal in May 1987, assessed the situation as severe, and made recommendations for immediate action on the part of USAID and the Government of Senegal (LaVoie and Elias,

1987). During site visits to the Senegal River Valley, they found extremely high densities of the unstriped grass rat and the multimammate rat (*Mastomys [=Praomys]*) species. The cowpea-millet-peanut agricultural area from Louga to Linguere was also reported to be heavily infested with the slender gerbil (*Taterillus gracilis*) at that time.

Another visit was made by Mr. LaVoie in February 1989 to assess rodent populations when "normal" densities could be expected--specifically to identify rodent pest species, to estimate their densities as relative to crop types and geographical areas, and to make quantitative rodent damage assessments to growing crops. He found that rodent populations in the Senegal River Valley were still at very good densities, the highest at Matam, followed by St. Louis, Kaedi, and Richard Toll, respectively. Damage assessments indicated severe rodent damage to seeds and seedlings. However, because very few crops were being grown at that time, assessments were limited. He recommended implementing a national rodent control program for Senegal and preparing for potential future rodent outbreaks.

This trip was a followup to Mr. LaVoie's 1989 visit to compare current findings with previous ones and to ascertain in-country capabilities for monitoring rodent populations.

FINDINGS

Rodent Populations

Visits were made to irrigated vegetable fields, fallow rice fields, and sandy areas at several sites (St. Louis, Richard Toll, Dagana, Podor, and Matam) along the Senegal River Valley. Snap traps, both rat-sized and mouse-sized museum specials, were set 2 at each point and at 10-m intervals in trap lines in fields, along fencerows, in sandy areas, along ditches, and in houses. The number of traps at each site was arbitrary, based upon the abundance of rodent evidence (burrows, runways, etc.) and available traps. Traps were baited with a mixture of peanut butter/rolled oats. Captured rodents were identified, sexed, weighed, and measured, and their reproductive condition was noted. Some specimens were prepared as skins and skulls, while others were preserved intact in 70% alcohol. Counts of rodent burrows along 100-m transects in fields, along ditches and fencerows, and in sandy scrub areas were made to estimate relative rodent activity.

Trapping results are summarized by location and habitat in Table 1. Captures of *Arvicanthis* and *Mastomys* were excellent at Richard Toll, Dagana, and St. Louis, in fencerows surrounding irrigated fields of vegetables (sweet potato, onion, tomato), and along moist ditches in fallow rice fields. At all other sites, however, including fields of irrigated mixed vegetables at Matam, captures were low to nonexistent. This lack of rodent activity was especially noticeable at Podor, Matam, Bambey, and Kaffrine (where only house mice were taken in the traps at the latter site). *A. niloticus* comprised 51% of the collection; *M. huberti*, 23%; *Mus musculus*, 19%; and *T. gracilis*, 4%. A listing of the sex, weights, and measurements of all captured animals is given in Annex I. Identification of *M. huberti* is based upon Duplantier et al. (1990*a* and 1990*b*).

Table 1. Trapping results by location and habitat.

Location	Habitat	Traps set	Effective trapnights (ETN)	Captures An	Mh	Mm	Tg	Misc	Tot	/ETN
Richard Toll	Fallow rice	57	50	7	18	-	-	-	25	0.50
Dagana	Fencerow, sweet potato fields	60	53.5	25	-	-	-	-	25	0.47
Matam	Irrigated mixed vegetables	50	48.5	-	-	-	-	1	1	0.02
Podor	Forest nursery	10	10	-	-	-	-	-	0	0.00
	Houses	31	31	-	-	2	-	-	2	0.06
St. Louis	Fencerow, mixed vegetables	50	49	7	-	-	-	1	8	0.16
St. Louis	Sandy plateau	30	25	-	-	-	3	-	3	0.12
Bambey	Fencerow, fallow millet field	30	28	-	-	-	-	-	0	0.00
Kaffrine	Peanut storage	24	19.5	-	-	2	-	-	2	0.10
Kaffrine	Fruit market	13	10	-	-	5	-	2*	5	0.50
Kaffrine	Melons	21	20.5	-	-	6	-	-	6	0.29
Totals		376	345	39	18	15	3	4	77	0.22

* One *Rattus rattus* and one *Cricetomys gambianus* were caught by villagers.
An = *Arvicanthis niloticus*, Mh = *Mastomys huberti*, Mm = *Mus musculus*,
Tg = *Taterillus gracilis*, and Misc. = one *Gerbillus henleyi* and one *Crocidura* spp.

Burrow counts corroborated the trapping results (Table 2). Only at Richard Toll did burrow counts approach those noted by LaVoie during his 1989 visit.

Mr. LaVoie recorded counts ranging from 3.0 to 51.7 along 100-m transects. Most counts recorded during this trip ranged from 2.5 to 8.0/100-m transect.

Rodents were damaging sweet potatoes at Matam, house mice were damaging melons at Kaffrine, and the ground squirrel (*Xerus erythropus*) was damaging cassava at the village of Kheur Assane NDiaye about 15 km north of Thies.

Farmers were interviewed at Dagana, Podor, Matam, and Kheur Assane NDiaye about current and past rodent problems. All reported no rat problems since 1988-89. There was a virtual absence of rats in the Diourbel/Kaolack/Kaffrine area; only the ground squirrel was seen.

Table 2. Burrow counts on 100-m transects during 1989 and 1992.

Location	Mean No. burrow openings	
	LaVoie 1989	Brooks 1992
Matam		
Rice	39.7	-
Vegetables	51.7	2.5
Sorghum	3.0	-
Podor		
Rice	-	8.0
Richard Toll		
Rice	7.8	29.3
St. Louis		
Rice	29.2	-
Vegetables	14.0	-
Pasture	22.0	-
Bambey		
Fallow millet	-	4.3
Diourbel		
Fallow millet	-	4.5

Rainfall Data

Rainfall data were obtained from USAID. The annual precipitation since 1981 is given in Fig. 1 for the several sites visited in the Senegal River Valley. All sites have shown deficient rainfall for the past 2 to 3 years (using the 30-year average as normal). Rainfall was especially deficient during 1991, averaging only 56 to 60% of the 30-year average, except for Podor, which received only 38%. As shown by the data, rainfall in the valley has been normal or above the 30-year average for only 2 or 3 of the past 11 years (30-year average for Matam, 410 mm; for Podor, 257 mm; and for St. Louis, 266 mm).

In the peanut-growing basin, the rainfall for Thies, Diourbel, Bambey, and Kaolack is given in Fig. 2. The pattern here is somewhat different from that recorded along the river valley. At Kaolack, the southernmost station, rainfall was adequate, but still below normal in 1984 and 1985, while at the other stations it was deficient, corresponding more to the pattern seen farther north in the valley. All basin sites had above average rainfall in 1988 and 1989. However, like in the Senegal River Valley, rainfall during the last 2 years in the peanut basin has fallen far below normal (30-year average for Bambey, 488 mm; for Thies, 546 mm; for Diourbel, 581 mm; and for Kaolack, 643 mm). Both areas have now had 2 years of drought. If the next 2 years should bring rains of normal or above normal amounts, this could precipitate a rodent population outbreak.

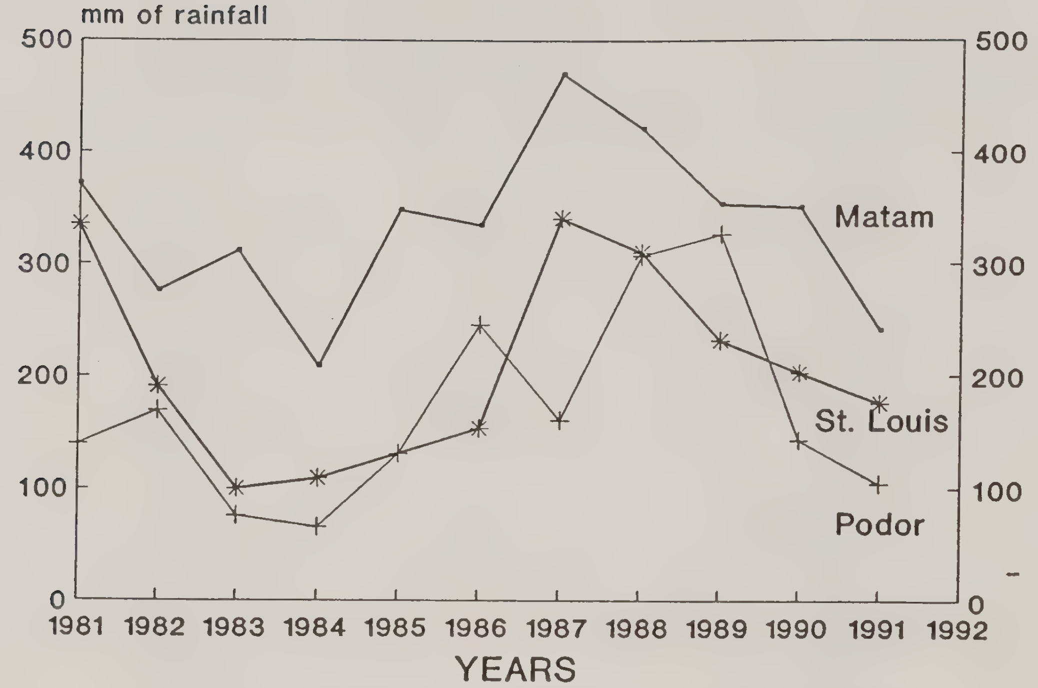

Fig. 1. Rainfall in mm for several stations in northern Senegal.

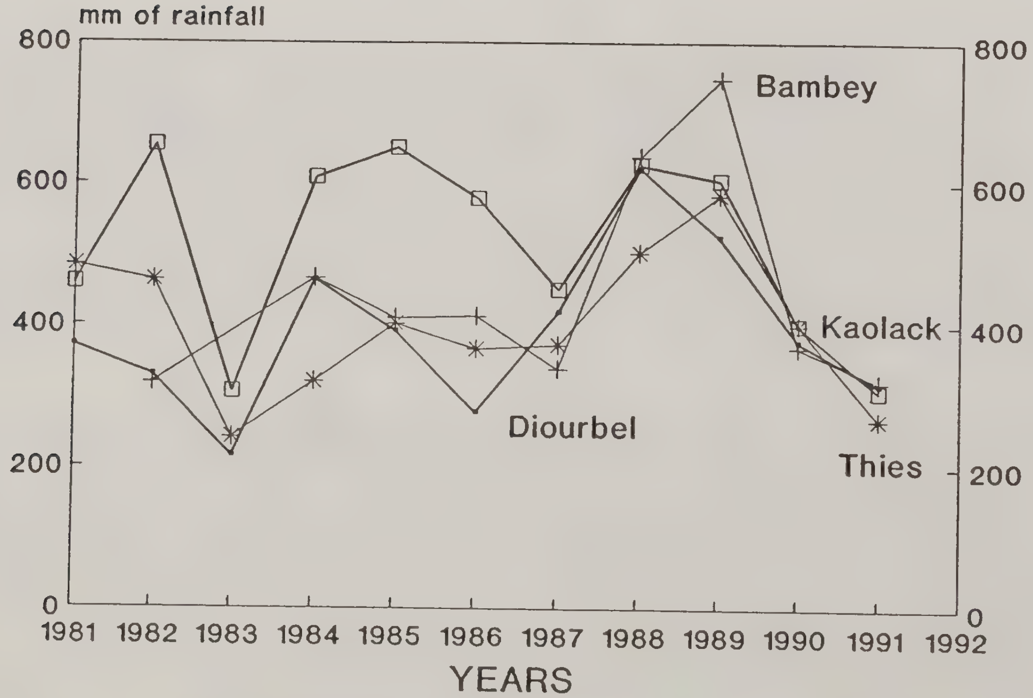

Fig. 2. Rainfall in mm for several stations in central Senegal.

The irrigation of rice, followed by vegetable crops at the river valley sites, has allowed *Arvicanthis* and *Mastomys* populations to maintain themselves at abundant levels despite several years of drought. Both species have the breeding potential to respond quickly to improved environmental conditions following abundant rainfall. Only two normal rainy seasons could, in fact, trigger that potential.

In-country Capabilities

The in-country capabilities for rodent population monitoring are excellent. This capability exists within the Department of Crop Protection in the Ministry of Rural Development. All they lack are the equipment and supplies (traps and dissecting kits), a monitoring protocol, and a minimum of in-country training in rodent population monitoring methods. Through a country-wide network of Crop Protection inspectors and heads of Locust and Grasshopper Survey Centres, a cadre of persons trained in surveillance, evaluation, monitoring, and reporting is available. Some of them received training in rodent control methods in Niamey, Niger, in 1988 and 1991 (copy of the training outline is presented in Annex II).

Mechanisms also exist for implementing rodent control programs, should the need arise. These are the Village Brigades, consisting of two to three individuals at each village who carry out limited locust/grasshopper control and report significant findings to the Survey Centres. These individuals could be easily and quickly trained in rodent control methods.

Chlorophacinone is the rodenticide available in-country and dispensed by the Extension Agents and Crop Protection personnel. Prepared baits, chlorophacinone mixed with rice bran, are given to farmers and villagers on request.

A resident rodent expert, Dr. J. M. Duplantier, ORSTOM, is available for consultation with the Crop Protection Department. Dr. Duplantier has spent several years in Senegal working on rodent problems and is currently involved with monitoring rodent populations at Richard Toll in connection with a schistosomiasis study. During my visit I had a chance to meet with Dr. Duplantier and see his office and laboratories.

Guinea-Bissau Crop Protection

I spent an evening with Mr. Mustafa Cassama, the Director of the Guinea-Bissau Crop Protection Service, and a member of his staff, Mr. Laurenco Abreau. They were in Dakar for a Crop Protection Conference. They are quite interested in cooperative involvement with DWRC in rodent population monitoring and would provide logistic support to future TDY'ers.

CONCLUSIONS

Rodent populations in the Senegal River Valley are less than recorded by Mr. LaVoie in his February 1989 visit, but higher than normal for this time of year. According to Dr. Duplantier, the two species of pest rodents

(*Arvicanthis* and *Mastomys*) generally begin breeding about midway during the rainy season, which is July through September, and then cease breeding about January. Populations reach their low points of the year just prior to the onset of the next rainy season. This year, however, the rats were still breeding in March, and some females showed signs of having had two litters during the current breeding season. The high proportion of immature animals in the populations will become the breeders when the next rainy season starts. The sites where rodents were more abundant than normal (St. Louis, Richard Toll, and Dagana) could be trouble spots if the next two rainy seasons are normal or above normal. There were other sites in the river valley where these two species of pest rodents were virtually lacking, as at Podor and Matam, but Mr. LaVoie had found them to be abundant in 1989. Most farmers remember 1988-89 as the last time in which they had significant rodent problems in their fields.

Field rodent populations in the Thies, Bambey, Diourbel, Kaolack, and Kaffrine areas were nonexistent, except for *X. erythropus* populations. Burrows of these ground squirrels were the only rodent evidence along fencerows in the peanut basin. Very few farmers from these areas recalled the 1988-89 rodent outbreak, because the outbreak apparently had not affected them. One cassava farmer near Thies reported that he had two kinds of rats in abundance that year, a daytime rat (*Arvicanthis*) and a nighttime rat (*Mastomys*).

Dr. Duplantier, rodent specialist at ORSTOM, indicated that their trapping at Richard Toll in early March showed populations of *Arvicanthis* and *Mastomys* had been higher than normal and that the current breeding season had been prolonged since late August 1991. If the next two rainy seasons are normal or above normal in the northern part of the country, there could be a rodent outbreak by late 1993 in the Senegal River Valley. Such an eventuality should be monitored for and, if an outbreak appears likely, steps should be quickly taken by the Department of Crop Protection for preventive actions.

ACKNOWLEDGMENTS

I appreciate the helpful assistance extended me by Mr. David Delgado and Mr. Mamadou Ba, USAID, in setting up my in-country tour. I particularly thank Mr. Séni Diémé, my counterpart from the Department of Crop Protection, for his help in guiding me and for his kind companionship in the field. Dr. Jude Andreasen gave her advice and assistance and provided me with several useful contacts. My thanks to her. Dr. Duplantier kindly helped with the identification of several rodent species.

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Annex I. Animal captures by location and date.

Date	Anim. No.	Location	Species	Sex	Wgt.	HBL	Tail	Remarks
3/17/92	1	Richard Toll	An	M	130	162	140	
"	2	" "	An	F	110	153	121	1 set scars (7)
"	3	" "	An	F	106	148	130	
3/18/92	4	" "	Mh	F	22	95	90	Immature
"	5	" "	Mh	M	17	83	77	"
"	6	" "	Mh	F	19	92	86	"
"	7	" "	Mh	F	13	78	75	"
"	8	" "	Mh	F	18	98	82	"
"	9	" "	Mh	M	14	87	84	"
"	10	" "	Mh	F	22	104	93	"
"	11	" "	Mh	F	11	80	72	"
"	12	" "	Mh	F	16	90	79	"
"	13	" "	Mh	F	14	90	77	"
"	14	" "	Mh	?				Partly eaten
"	15	" "	Mh	?				" "
"	16	" "	Mh	?				" "
"	17	" "	Mh	?				" "
"	18	" "	An	M	106	150	122	
"	19	" "	An	F	164	180	135	1 set scars (6)
"	20	" "	An	F	125	160	125	2 scar sets (14)
"	21	" "	An	M	121	162	116	
"	22	" "	Mh	F	30	108	88	No scars
"	23	" "	Mh	F	42	127	102	" "
"	24	" "	Mh	F	29	114	95	Immature
"	25	" "	Mh	F	20	103	90	"
3/18/92	26	Dagana	An	F	74	131	126	"
"	27	"	An	M	130	160	132	
"	28	"	An	M	108	150	126	
"	29	"	An	M	126	160	147	
"	30	"	An	M	100	150	132	
"	31	"	An	F	38	105	99	Immature
"	32	"	An	F	78	136	120	"
"	33	"	An	F	73	134	112	"
"	34	"	An	M	84	143	118	"
"	35	"	An	M	106	160	131	
"	36	"	An	M	77	139	116	Immature
"	37	"	An	F	80	146	119	"
"	38	"	An	F	151	166	161	
"	39	"	An	M	85	148	125	Immature
"	40	"	An	F	53	116	97	"
"	41	"	An	F	39	108	96	"
"	42	"	An	M	78	141	118	"
"	43	"	An	M				Partly eaten
"	44	"	An	M	176	187	145	
"	45	"	An	M	74	134	116	Immature

Annex I. Continued.

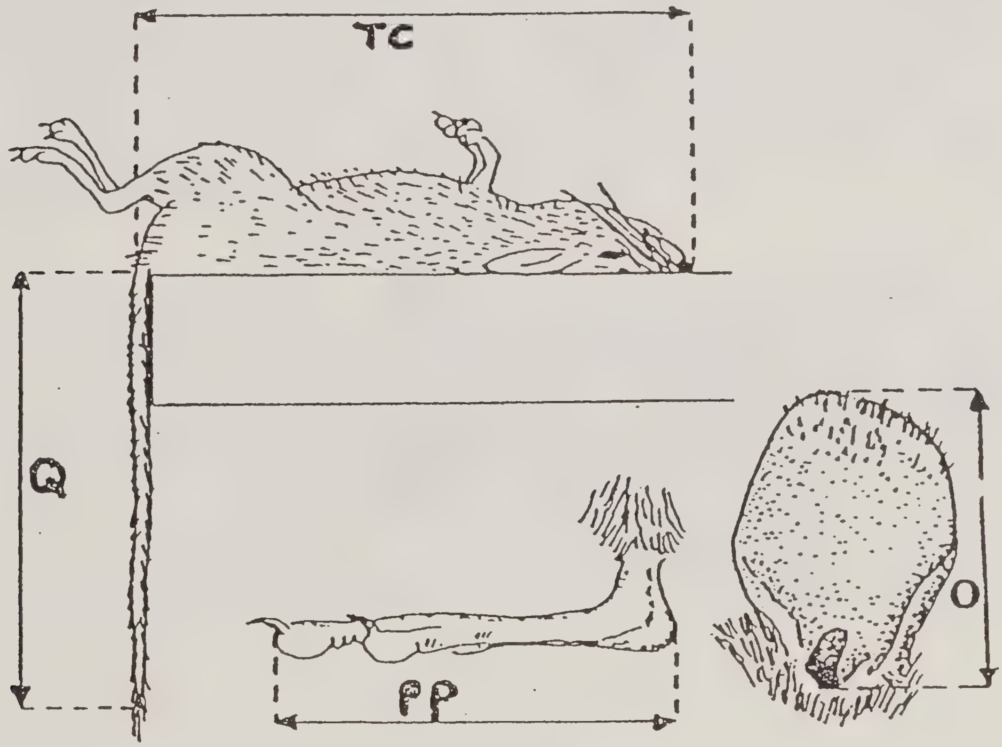
Date	Anim. No.	Location	Species	Sex	Wgt.	HBL	Tail	Remarks
3/19/92	46	"	An	?			103	Tail only
"	47	"	An	F	30	97	86	Immature
"	48	"	An	F	128	147	130	Pregnant (6) No scars
"	49	"	An	F			111	Partly eaten
"	50	"	An	?			126	" "
3/20/92	51	Matam	Gh	M	9	66	87	Scrotal
"	52	25 km NW Matam	Xe	M				Road kill
3/21/92		Podor	Mm					
"		"	Mm					
3/22/92	53	St. Louis	An					Immature
"	54	" "	An					"
"	55	" "	An					"
"	56	" "	An					"
"	57	" "	Tg	M				
"	58	" "	Tg	F				
"	59	" "	Tg					
"	60	" "	An	F	134			
"	61	" "	An	M	156			
"	62	" "	An	F	174	147	129	Pregnant (6)
"	63	" "	Crocidura					Partly eaten
3/23/92	64	Kaffrine	Rr	F	98	156	199	1 set scars
3/24/92	65	"	Cg	M	>500	271	296	Captured by villagers
"	66	"	Mm	F	5	60	56	
"	67	"	Mm	M	5	62	52	
"	68	"	Mm	M	16	85	71	
"	69	"	Mm	F	15	85	77	
"	70	"	Mm	M	14	81	77	
"		"	Mm	8 animals discarded				

**DEPARTEMENT DE FORMATION
EN PROTECTION DES VEGETAUX**

ADRESSER TOUTE CORRESPONDANCE A : / ADDRESS ALL CORRESPONDENCE TO : D.F.P.V. B.P. 12625 NIAMEY - NIGER

dfPv

Annex II. Training Course Outline, Niamey, Niger.



ATELIER DE FORMATION SUR
LA LUTTE ANTI-RONGEURS
(8 AU 25 AVRIL 1991)

TEL. 73.21.81 - TELEX 5545 DFPV NI - TELECOPIE 73.22.37
COMITE PERMANENT INTER-ETATS DE LUTTE CONTRE LA SECHERESSE DANS LE SAHEL (CILSS)
CENTRE AGRHYMET, DEPARTEMENT DE FORMATION EN PROTECTION DES VEGETAUX

RAPPORT DE L'ATELIER SUR LES RONGEURS

TABLE DES MATIERES

ANNEXES

<u>INTRODUCTION</u> : L'organisation des ateliers de formation figure parmi les activités du Département de Formation en Protection des Végétaux (DFPV). Les thèmes de ces ateliers sont souvent axés sur des sujets d'actualité en matière de production agricole dans les Etats-membres du Comité Permanent Inter-Etat de Lutte Contre la Sécheresse dans le Sahel (CILSS).

C'est ainsi que sur une recommandation des Directeurs des Services Nationaux de la Protection des Végétaux faisant suite à l'appel lancé par le Conseil des Ministres du CILSS réunis à Ouagadougou les 28 et 29 Janvier 1987, le DFPV a organisé du 11 au 28 Janvier 1988, un atelier sur la lutte anti-rongeurs cette initiative avait pour but de faire face aux graves dégâts causés par les rongeurs à travers le perfectionnement des agents opérant sur le terrain.

Les Directeurs de la Protection des Végétaux, lors de la 5ème réunion du Comité Scientifique et Pédagogique tenue au DFPV du 10 au 13 Juillet 1990, ont une fois encore récommandé la tenue d'un deuxième atelier sur la lutte anti-rongeurs. Ceci témoigne l'importance que les Etats-membres du CILSS attachent à ce problème considéré comme un fléau dans plusieurs pays sahéliens.

C'est en réponse à cette recommandation des Directeurs que le DFPV a tenu un deuxième atelier sur la lutte anti-rongeurs du 8 au 25 Avril 1991.

OBJECTIFS DE L'ATELIER

- Renforcer les connaissances des techniciens sur la biologie des principaux rongeurs nuisibles dans la région soudano-sahélienne et sur leur dynamique de population pour une meilleure organisation de la lutte;

- Reconnaître les principales espèces;

- Apprendre les techniques de capture pour une meilleure approche de l'étude de la dynamique des populations des rongeurs;

- Apprendre les méthodes d'évaluation de la sévérité des dégâts causés par les rongeurs;

- Apprendre les principales méthodes de lutte et leurs applications sur le terrain;

- Organiser une lutte anti-rongeur sur une vaste échelle;

- Avoir un aperçu des principaux raticides employés, de leur mode d'action, de leur efficacité et de leur toxicité;

- Etudier la possibilité d'instaurer un système de surveillance et d'alerte précoce.

DEROULEMENT DE L'ATELIER

Vingt deux participants venant des Directions Nationales de la Protection des Végétaux des 9 pays du CILSS (Burkina Faso, Cap-Vert, Gambie, Guinée-Bissau, Mali, Mauritanie, Niger, Sénégal et Tchad) ont assisté à ce deuxième atelier (Annexe I) . L'organisation logistique et la coordination de l'atelier ont été assurées par le DFPV. Quant à l'encadrement technique, il a été assuré par une équipe d'experts ayant accumulés une bonne expérience dans le domaine de la lutte anti-rongeurs, surtout dans la zone sahélienne (Annexe II).

La tenue de cet atelier a été possible grâce aux concours des organismes suivants :

- Le Directorat Général pour la Coopération Internationale (DGIS) des Pays Bas, pour le financement.

- Le programme des Nations-Unies pour l'Alimentation et l'Agriculture (FAO), pour le financement de deux participants.

- L'Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM), pour la participation de deux encadreurs et un technicien.

- La Coopération Suisse, pour la participation d'un encadreur

- La Coopération Technique Allemande (GTZ), pour la participation d'un encadreur.

Le programme de formation exécuté lors des trois semaines de travaux, ainsi que le contenu du programe, figurent respectivement en Annexes III et IV). La formation a été orientée vers les aspects pratiques de la lutte anti-rongeurs; à savoir la reconnaissance des principales espèces sahéliennes, les techniques de piègeage et d'épandage de raticides, les dissections au laboratoire et la préparation des collections de référence. L'aspect des essais rodenticides au laboratoire a été mieux devéloppé par rapport au premier atelier. Ceci a été possible grâce à la disponibilité de rongeurs en nombre suffisant et ce bien avant le commencement de l'atelier. Ainsi, le temps qui devrait être consacré à la capture des animaux a pu être utilisé pour les pratiques de laboratoire.

Un autre point ayant contribué au meilleur déroulement de ce deuxième atelier par rapport au premier est qu'avant le commencement des travaux de l'atelier un temps suffisant a été dégagé pour permettre aux encadreurs de discuter du programme en profondeur, de faire la répartition des tâches d'enseignement et de planifier les différentes activités pratiques dans le temps .

Cette planification des activités pratiques a permis d'organiser des sorties pédagogiques (piégeage, épandage des raticides, etc) au Centre Sahélien de l'International Crops Research Institute for the Semi-Arid Tropics. (ICRISAT), à Sadoré, dans les greniers des villageois et de quelques exploitations agricoles aux alentours de Kolo, à la Ferme Nouvelle (Ferme avicole) et aux magasins de l'Office des Produits Vivriers du Niger (OPVN).

Aussi bien que les cours théoriques, ces activités pratiques se sont déroulés avec satisfaction de tous ;en fait, un regard sur les résultats de l'évaluation des participants à l'issue de l'atelier nous permet de dégager les observations suivantes :

- les participants ont apprécié d'une manière générale l'enseignement des différentes matières.
- la répartition des différentes activités (exposés, travaux pratiques, repos, etc) a été bien faite.
- une large majorité de participants a acquis des connaissances nouvelles durant l'atelier.
- la plupart de participants pense que les connaissances acquises durant l'atelier leur permettront de mieux aborder certains problèmes techniques relatifs aux rongeurs (par exemple : organisation de lutte; épandage de raticides, reconnaissance des espèces).
- les moyens didactiques ont été jugés bons.
- l'organisation logistique et technique de l'atelier était satisfaisante pour la majorité de participants.

L'évaluation de l'atelier nous a aussi permis d'identifier les sujets qui ont été les plus appréciés par les participants, ainsi que les sujets nécessitant un approfondissement dans les ateliers ultérieurs et quelques recommandations.

* <u>Sujets les plus appréciés</u>

- Planification de la lutte et techniques d'intervention
- Systématique/reconnaissance des rongeurs
- Tests de raticides au laboratoire
- Biologie et reproduction des rongeurs

* Sujets à approfondir

- Estimation des dégâts
- Echantillonnage et analyse des données
- Tests de raticides en plein champ.
- Biologie des rongeurs
- Aspects lutte.

* Recommandations

- Les participants ont noté un manque de diversité dans la collection systématique de rongeurs du DFPV et souhaiteraient voir une amélioration de celle-ci.
- A l'avenir une meilleure coordination entre les encadreurs serait nécessaire, surtout sur les exposés.
- La date de l'atelier doit être décalée prochainement pour coincider avec la période d'abondance maximale de rongeurs sur le terrain.

Il est à noter que ces mêmes remarques ont été faites par les encadreurs à la Direction du DFPV. Pour l'amélioration de la collection systématique du DFPV une suggestion de l'assistance du laboratoire de Mammalogie de l'ORSTOM (Ouagadougou) a déjà été faite pour completer dans la collection. En ce qui concerne la coordination entre les encadreurs, ceux-ci ont eux-mêmes suggéré de désigner (pour les ateliers à venir) un coordinateur pour chaque sujet à enseigner. Pour ce qui est de la meilleure date pour un atelier de ce genre la Direction du DFPV a pris bonne note des souhaits des encadreurs et des participants la période la plus indiquée se situant entre Décembre et Février.

Résultat du contrôle de connaissance

Un contrôle de connaissance a été organisé à la fin des travaux de l'atelier. Quinze participants ont obtenu des résultats satisfaisants et ont reçu un Certificat d'Aptitude. Par contre les sept participants ayant obtenu des résultats insuffisants ont reçu des certificats de participation.

ANNEXE III

ATELIER DE FORMATION SUR LA LUTTE ANTIRONGEURS : 8 - 25 AVRIL 1991 / PROGRAMME

		MATIN		SOIR	
L	8	OUVERTURE OFFICIELLE		REUNION DES ENCADREURS	
M	9	TESTS DE LABORATOIRE; TEST DE PLEIN CHAMP (TROUS)		QUESTIONNAIRE/ INTROD. "LES PROBLÈMES RONGEURS"	G D B M
M	10			SYSTEMATIQUE ET REPARTITION	G/D
J	11			BIOLOGIE DES RONGEURS	M
V	12	ECHANTILLONNAGE FAUNISTIQUE		REPRODUCTION ET CYCLES	D
S	13	DISSECTION	D	//////////////////////	
D	14			//////////////////////	
L	15	////////		//////////////////////	
M	16	ECHANTILLONNAGE LINEAIRE		ECHANTILLONNAGE	G
M	17	GRENIERS		MISE EN PEAU/COLLECTION	O/M
J	18			ESTIMATION DES DEGATS LUTTE ET PREVENTION	B/M
V	19			RODENTICIDES TESTS	M/G
S	20	PREPARATION APPATS	B	//////////////////////	
D	21	//////		//////////////////////	
L	22	FERME ET MAGASIN		PLANIFICATION LUTTE TECHNIQUES D'INTERVENTION	G D B M
M	23	AUTOPSIE	M	REVISION GENERALE QUESTIONS ET DISCUSSION	G D B M
M	24			CONTRÔLE DES CONNAISSANCES TABLE RONDE	G D B M
J	25	CLÔTURE			

ATELIER DE FORMATION LUTTE ANTI-RONGEURS

Proposition de programme
---- O ---
Contenu

1. THEORIE

1.1. Introduction générale

- Aperçu global sur les problèmes posés par les rongeurs sur le plan de la production agricole et sur le plan de la santé publique.
  Particularités de ces problèmes dans la région sahélienne.

1.2. Systématique/reconnaissance des rongeurs

- Classification des rongeurs.
- Morphologie générale des rongeurs.
- Reconnaissance des principales familles et espèces suivant des critères externes, des dégâts et d'autres indices (exemple : crottes, traces, terriers, etc).
- Marquage, utilisation des colorants, etc.

1.3. Piègeage et surveillance des populations

- But et importance du piègeage.
- Types de pièges et méthodologie de piègeage; évaluation des méthodes, etc.
- Prévision et signalisation des pullulations à partir des données du piègeage.
- Etablissement d'un réseau de surveillance et sensibilisation de la population.

1.4. Biologie et écologie

- Cycle de reproduction et d'abondance dans le temps et dans l'espace.
- Comportement sexuel.
- Détermination de l'activité sexuelle chez les mâles et les femelles.
- Dynamique des populations : différentes méthodes d'estimation de la densité (capture - marquage; défrichement des parcelles infestées, etc); estimation de la mobilité (immigration et émigration); facteurs biotiques et abiotiques de mortalité.
- Habitudes alimentaires des espèces importantes du Sahel.

1.5. Evaluation des pertes

- Les types et les causes des pertes et des dégâts occasionnés par les rongeurs.
- Les différentes méthodes d'évaluation des pertes
  * sur les cultures en plein champ
  * sur les denrées stockées.

1.6. Les aspects de la lutte

- Méthodes non-chimiques :
  * effets des prédateurs
  * méthodes agroécologiques
  * méthodes physiques - protection en utilisant des barrières
  * effarouchement - optique, acoustique.

- Méthodes chimiques :
  * Identification de la molécule et du support à utiliser.
  * Les différentes catégories de rodenticides, leurs avantages, inconvénients et modes d'utilisation; précautions à prendre et conditions d'utilisation des différentes molécules.
  * aspects toxicologiques des rodenticides et les effets sur l'environnement.

- Dératisation des entrepôts :
  * Mesures sanitaires et autres méthodes de prévention.
  * Utilisation des rodenticides dans les entrepôts - précautions particulières, types de produit conseillés et méthodes d'application.

- Mobilisation des ressources et moyens pour une campagne de lutte
  * Aspects logistiques.
  * Sensibilisation de la communauté - voies et moyens
  * connaissance du milieu.
  * Mise en place des dispositifs, exécution et suivie de l'opération de lutte.
  * Relever des données, évaluation et rapport.

2. PRATIQUE

2.1. Piègeage :

* à effectuer dans différentes zones écologiques : friches, vergers, périmètres rizicoles et maraîchers, greniers traditionnels des paysans et magasins de stockage. Pour permettre aux participants, de voir la variation qualitative et quantitative des rongeurs suivant le milieu piégé;

* les participants doivent apprendre l'aspect pratique du piégeage - emplacement des pièges, maille de piègeage (nombre de pièges par unité de surface), choix de l'appât et le type de piège selon le besoin; la collecte et l'interprétation des données de piègeage.

2.2. Systématique/reconnaissance

* reconnaissance de toutes les espèces capturées (visuellement à partir de la morphologie des animaux, ou à travers la morphométrie).

2.3. Biologie

* A travers la dissection : apprendre les techniques de dissection, observer globalement les organes internes (anatomie) et apprendre à reconnaître l'état de reproduction des rongeurs mâles et femelles.

2.4. Organisation et exécution de la lutte

* Observation sur quelques rodenticides couramment employés en lutte anti-rongeurs et tests de leurs efficacités au laboratoire.

* Préparation des appâts (démonstration).

* Epandage de raticide après préappâtage ou piègeage pilote
  - dans une parcelle infestée,
  - dans un entrepôt.

* Contrôle de la consommation de l'appât; suivi de la mortalité.

* Observations des rongeurs morts par intoxication (effets des anticoagulants).

* Evaluation de l'efficacité de la lutte (exemple : par piègeage post-traitement).

NB : Des zones infestées pourraient déjà être identifiées pendant le cours TSPV-2 en lutte anti-rongeurs qui précède l'atelier.

2.4. Préparation et entretien d'une collection de référence

* Techniques de mise en peau.

- Matériels didactiques requis :

  - séries de diapositives,
  - affiches/posters,
  - films vidéo (VHS).

- Documentation :

  - tirés-à-part,
  - livres, brochures, etc.

TRIP REPORT*

AN ASSESSMENT OF RODENT CONTROL PROGRAMS AND PROBLEMS IN NIGER, BURKINA FASO, MALI, AND COTE D'IVOIRE

March 17-April 13, 1992

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Unpublished Report

July 8, 1992

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ITINERARY

Date	Location	Activity
Mar 17	Denver, Colorado, to Washington, D.C.	Travel
Mar 18-19	Washington, D.C., to Niamey, Niger	Travel
Mar 20-25	Niamey	Met with U.S. Agency for International Development (USAID), Ministry of Agriculture (MOA) Crop Protection, Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM), and visited agricultural areas near Tillabery. Presented seminar on Sahelian rodents at USAID.
Mar 25	Niamey to Bamako, Mali	Travel
Mar 26-30	Bamako	Met with USAID, MOA Crop Protection, and Institut du Sahel (INSAH).
Mar 30	Bamako to Ouagadougou, Burkina Faso	Travel
Mar 31-Apr 5	Ouagadougou	Met with USAID, MOA Crop Protection, and Madam BA Daoulé Diallo (INSAH).
Apr 6	Ouagadougou to Abidjan, Côte D'Ivoire	Travel
Apr 7	Abidjan to Bouaké, Côte D'Ivoire	Travel; met with USAID/ Regional Economic Development Services Office (REDSO), Agriculture Attache, U.S. Embassy.
Apr 7-9	Bouaké	Met with West African Rice Development Association (WARDA), trapped rodents on WARDA research farm, and attended portions of WARDA in-house review.
Apr 10	Bouaké to Abidjan	Travel; attended debriefing with USAID/REDSO office.
Apr 11-13	Abidjan to Denver, Colorado	Travel

ABSTRACT

Rodent problems in Niger, Mali, and Burkina Faso appear to be similar to those described in the Chad/DWRC Rodent Control Research Project. The main problems are (1) the loss of millet and sorghum seed during the early portion of the rainy season, (2) damage to maturing irrigated rice from October through January, and (3) losses to a variety of winter season vegetables. Both rodents and birds are major pests to field crops and postharvest storage of grains. In Niger, the Crop Protection Service (CPS) has two rodent control specialists with an excellent knowledge of the country's rodent species and the damage problems, whereas in Mali and Burkina Faso, Crop Protection programs are lacking such expertise. The West African Rice Development Association (WARDA) in Côte d'Ivoire is a regional institute providing technology development of rice-based cropping systems in 17 countries. Although vertebrate pest control is not currently emphasized at WARDA, the institute is aware of the potential of vertebrate pests in crops and has identified rodent and bird problems in Côte d'Ivoire rice fields.

OBJECTIVES

The purpose of this trip was to determine the current status of agricultural pest rodent populations in Sahelian countries and to determine the feasibility of establishing rodent population monitoring sites and a regional rodent monitoring network that would provide an early warning of impending rodent outbreaks. Also, this consultancy provided the opportunity to confer with the host country and donor agencies, institutes, and programs having an interest in rodent control.

ACCOMPLISHMENTS

Niger

The General Development Office, Disaster Relief Unit within the AID/Niamey Mission, is in the process of formulating a disaster mitigation plan (DPM) which will provide more appropriate responses and early warnings to reduce the impact of drought, famine, and disease epidemics as well as insect and rodent outbreaks. Although a contract team was in Niamey to write the DPM, I drafted a position paper on rodent outbreaks for inclusion in the plan (see Appendix I). A few rodent control training programs sponsored by the Centre International pour le Lutte Contra le Secheress (CILLS) have been held at the Agromet Center in Niamey for crop protection personnel in the region.

Both Canadian and German assistance programs in the CPS have, after several years, ended. However, two Niger counterparts are knowledgeable about rodents and the problems they cause in Niger. A rodent manual written by Mr. M. Sani Elhaj Adam, who is currently in Japan on a study tour, was completed with assistance from the GTZ (German Society for Technical Cooperation). A second counterpart, Mr. Hama Belko, briefed me on Niger rodent problems.

The principal rodent pest species in Niger field crops include the gerbil (*Gerbillus gerbillus*), jerboa (*Jaculus jaculus*), and Nile rat (*Arvicanthis niloticus*). Stored grain or food pests include the roof rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), Nile rat, multimammate rat (*Praomys* [=*Mastomys*] *natalensis*), and two gerbils (*Gerbillus* sp. and *Taterillus* sp.).

Rodent populations need to be continuously monitored to determine their relative densities and their potential for crop damage. Although several different methods of monitoring rodent populations are available, we selected the headlight survey method which counts the number of rodents within the headlight beam of a vehicle moving at a given speed along a selected 1-km route. This method has worked well in Sudan and should establish a baseline in Niger from which rodent increases will become noticeable long before rodent outbreaks occur.

Finally, I presented a seminar on rodent problems in the Sahel for five USAID and CPS personnel. I outlined the concepts of annual chronic damage and periodic population outbreaks, described the causes, and proposed some methods for mitigating the resulting crop losses. My conclusions emphasized the importance of monitoring rodent populations, assuring the availability of rodenticide stocks in strategic places, and developing methods to reduce the annual chronic crop losses caused by rodent pests.

Mali

Rodent problems in agricultural crops of Mali appear to be typically Sahelian. A flooded area along the Niger River (planted to broadcast rice) is not typical, but millet, sorghum, and vegetable crops are similar to those found in Niger and Chad. Maize is grown in an extensive area south of Bamako, where residents prefer this grain to rice or millet and sell portions of the maize harvest for animal feed, including poultry operations.

The Crop Protection Department (CPD) has no history of rodent control or personnel with any training or experience in this area. Although the CPD responds to major rodent control problems, it apparently is doing so at a tremendous handicap. The important rodent pests and preharvest problems have not been defined, though the problems most likely follow the seasonal patterns found elsewhere in the Sahel. Cropping calendars for millet, sorghum and rice are given in Table 1.

Field work is needed to define the major rodent problems, including the rodent species, the crops and their susceptible growth stages, and estimates of damage. Two individuals need to be trained in research techniques and control operations to offer competent rodent control recommendations to the farming community. The researcher would (1) gather the necessary background information from which preliminary control methods could be evaluated and (2) establish a monitoring system to follow seasonal and annual rodent populations to predict their outbreaks, while the individual handling control operations would be trained in extension and rodent control management techniques so to be able to provide recommendations to farmers. Training materials developed as part of the USAID/DWRC/MOA/CPS Rodent Control Research Project in Chad, particularly the French

translations, could be extremely useful since similar crops and rodent species are involved.

Institut du Sahel (INSAH)/CILSS through the Unité de Coordination Technique Regionale en Protection des Vegétaux (UCTR/PV) is located in Bamako, Mali. The Director, Madam BA, coordinates Crop Protection activities and information dissemination among the 9-member countries of West Africa. She has recognized the importance of vertebrate pests in field crops and storage sites and the need to improve knowledge and capabilities for farmers and CPS personnel. Madam BA is familiar with the DWRC and its efforts to improve vertebrate pest management technology and information dissemination in West Africa. A manuscript on rodent problems in the Sahel submitted by DWRC will soon be published by INSAH. I reviewed and made minor corrections to the prepublication copy and later delivered the corrected INSAH manuscript to Madam BA, who was in Ouagadougou, Burkina Faso where we discussed the changes as well as rodent control problems, management, and potential approaches to solutions for West Africa.

Burkina Faso

Mr. Ousséini Edos Yeye, Program Assistant, located an interpreter and arranged meetings with the Institut Francais de Recherche Scientifique pour le Developpement en Cooperation (ORSTOM) and the CPS. Both postharvest and preharvest damage is acknowledged, but has not been quantified. Rodent damage, after seeding of sorghum, millet, and maize from May through July, is a well-known problem to farmers. Vegetables, including tomatoes, carrots, and cabbage, are also damaged from December to February. Farmers use mostly traditional methods, including pitfall and a variety of other locally made traps. Rodenticides are not supplied by the government, but according to the CPS, farmers may purchase Klerat®[1] at local markets. Rodent populations are now declining to their low point, which should occur in May. Following the rains, which normally begin in May, populations stabilize and begin to increase again. Seeds planted at this time are particularly susceptible to rodent damage, due to a lack of other available food for these pests.

The CPS, directed by Mr. Ouédraoge Blaise, is engaged in pest control during outbreaks. Primary problems to crops involve insects (locusts and grasshoppers), birds, and rodents. Primary crops damaged by rodents include sorghum and millet, but cotton, rice, maize, and groundnuts are also affected. The CPS requested rodent control training, either short- or long-term technical assistance in the form of TDY support or a short-term assistance project. I interpreted this to mean hands-on training in rodent identification, research techniques, damage assessment, and preliminary control trials. Information (in French) from the Chad Project should be sent to Director Blaise for distribution to staff to improve their knowledge of Sahelian rodent problems. A field trip to a nearby agricultural area (Centre de Recherche de Kamboinsé) was made. Very little farming was in progress, but this research center was growing maize,

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

tomatoes, cassava (manioc), and onions. Surprisingly, very few rodent problems have ever been encountered on this farm.

I met with Dr. Jean-Claude Gautun, Director of ORSTOM in Burkina Faso. Dr. Gautun will resume duties as the mammalogist in about 2 months when a new Director arrives. He has attempted to cooperate with the Burkina Faso CPS by training someone for rodent work, but thus far without success. The ORSTOM Center in Ouagadougou is a relatively large center focusing on training, documentation, and general crop protection development. A laboratory houses a collection of live rodents, mostly Nile rats, multimammate rats, *Taterillus* sp., *Gerbillus* sp., and *Steatomys* sp. Some rodent control training by ORSTOM is being done for the same people that are being trained by DWRC and funded by AID and the Food and Agriculture Organization of the United Nations. We need to coordinate these activities to avoid duplication of training efforts.

Côte d'Ivoire/West Africa Rice Development Association (WARDA)

WARDA moved from its former location in Liberia to Bouaké, Côte d'Ivoire, in 1988. A research farm, offices, and laboratories are being established at a new site at M'be, about 30 km from Bouaké. The new site consists of 700 ha, including about 230 ha of lowland (irrigated from a dammed lake) and 340 ha of upland. Only about 50-70 ha have thus far been developed for use as research plots. The remaining land will be properly developed and added incrementally as needed. A new laboratory and office complex will be ready for occupancy in about 2 months when much of the staff and equipment will be moved from temporary quarters.

WARDA's primary mission is to help develop sustainable rice-based cropping systems in about 17 West African countries. This includes irrigated rice in very dry Sahelian areas as well as rice grown in mangrove swamps in coastal areas. Field stations are located at St. Louis, Senegal (Sahel Program), and at Rokupr, Sierra Leone (Mangrove Swamp Program). Research programs are now characterizing the major climatic environments, improving and utilizing germplasm, identifying sustainable cultural practices and water resource management, and evaluating the many constraints, including vertebrate pests associated with growing rice in West Africa. Irrigated rice is a relatively recent development in the Sahel, but it is expanding rapidly due to urban population preferences for rice over traditional sorghum and millet. Activities of the Sahel Program of WARDA will be concentrated near the Senegal River, the Niger River, and Lake Chad.

Rodent and bird problems in rice fields of Côte d'Ivoire have recently been identified by WARDA (Table 2). Rice farmers throughout the country were asked to describe the pest and the crop stage attacked, and to rank the incidence of each rice pest. Rodents ranked highest (abundant) included the grasscutter (*Thryonomys swinderianus*), western striped ground squirrel (*Xerus erythropus*), pygmy mouse (*Mus minutoides*), multimammate rat (*Mastomys erythroleucus*), roof rat (*Rattus rattus*), and the Nile rat (*Arvicanthis niloticus*). Grasscutters primarily damage maturing rice after the booting stage, while ground squirrels mostly damage seeded fields. Nile rats are most important in the lower, more moist savannas. Preharvest crop damage appeared more important in upland rice, while postharvest

losses from rodents were greater in lowland rice growing areas. Other mammal pests also identified as abundant included warthogs (*Phacochoerus* spp.) damaging early growth stages of rice grown in savanna habitat.

I had the opportunity to trap rodents in Côte d'Ivoire. Snap traps, 39 museum specials and 40 rat-size, were set in and adjacent to lowland rice fields (59 traps) and upland fallow fields (20 traps). In addition, museum special traps were set inside (3 traps) and outside (3 traps) a screenhouse near a corner where the plastic mesh screen had recently been gnawed through and seeded rice was being dug up. A total of 13 rodents and 2 toads were trapped overnight, while none were trapped during the daylight hours of a 24-hour trapping period (Table 3). Of the 11 rodents trapped in the field, 1 was a striped grass rat (*Lemniscomys striatus*) and 10 were multimammate rats (*Mastomys* sp.). Two male *Mastomys* sp. were trapped inside the screenhouse. They each resembled the *Mastomys* sp. that had been trapped in the field, but lacked the white ventral pelage (they had a gray ventral pelage) and a clear demarcation between the dorsal and ventral pelage. Study skins and skulls were prepared for future reference and identification. Standard measurements are summarized in Tables 4 and 5. Multimammate rats were the most abundant rodent captured on the WARDA research farm and appear to be most abundant in the lowland rice field habitat.

SUMMARY

Rodents are a major factor in limiting food production in the Sahel. Very little is known about the problem or how to manage it in Niger, Mali or Burkina Faso. Nile rats, mutimammate rats, gerbils and jerboas are responsible for damaging seeded millet and sorghum, irrigated rice and winter vegetables. This damage needs to be examined, characterized and quantified so that appropriate solutions can be recommended to farmers. Information from the USAID/DWRC Chad Rodent Control Project which dealt with similar problems from 1990-1992 should be useful for Niger, Mali and Burkina Faso Crop Protection programs.

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CONTACTS AND ACKNOWLEDGMENTS

Unfortunately, notification of amended travel dates was not received by USAID/Missions prior to my arrivals. This severely restricted activities and the accomplishment of objectives in Niger and Mali and posed moderate problems in Burkina Faso. Nevertheless, USAID/Missions provided the maximum support level possible including arrangements and logistics to meet appropriate officials.

<u>Niger</u>

- Dr. Charles Kelly, Disaster Relief Unit, General Development Office, USAID
- Dr. Helen Shoos, Head, General Development Office, USAID
- Mr. Kondo M. Sani, Project Assistant, General Development Office, Disaster Relief Unit
- Mr. Hama Belko, Rodent Specialist, Crop Protection, Ministry of Agriculture

<u>Mali</u>

- Mr. Wayne McDonald, Agricultural Office, USAID
- Mr. Mamadon Fofana, Program Assistant, General Development Office, USAID
- Mr. Sanghata Mabayo, Director, Crop Protection, Ministry of Agriculture
- Mr. Yacuba Kone, Department Head, Crop Protection, Ministry of Agriculture
- Mr. Amador Camara, Program Assistant, Farming Systems Program, USAID
- Dr. Madam BA, Director, Institut du Sahel (INSAH) Bamako, Mali

<u>Burkina Faso</u>

- Mr. Dennis McCarthy, Head, Agricultural Office, USAID
- Mr. Ousséini Edos Yeye, Program Assistant, Agricultural Office, USAID
- Ms. Benon Francoise, Program Assistant, Agricultural Office, USAID
- Dr. Jean-Claude Gautun, Director, ORSTOM
- Mr. Ouédraoge Blaise, Director, Crop Protection, Ministry of Agriculture
- Mr. Bamba, Crop Protection Staff Member, Ministry of Agriculture

<u>Côte d'Ivoire</u>

- Dr. Robert Hanchett, Regional Environmental Officer, REDSO, West Africa, Abidjan
- Dr. Randolph Zeitner, Agricultural Attache, U.S. Embassy, Abidjan
- Dr. Eugene Terry, Director General, WARDA, Bouaké
- Dr. Peter Matlon, Director of Research, WARDA, Bouaké
- Dr. Elvis Heinrichs, Entomology Program Leader, WARDA, Bouaké
- Dr. Michael Dingkuhn, Senior Physiologist, WARDA, Saint-Louis, Senegal
- Mr. Laurence Becker, Geographist, WARDA, Bouaké
- Mr. Roger Diallo, Research Associate, WARDA, Bouaké
- Dr. Tom Remington, Cropping Systems Agronomist, WARDA, Bouaké
- Dr. Harold Kauffman, India Coordinator, Plant Genetic Resources Project, New Delhi

Table 1. Cropping calendar of millet (M), sorghum (S), and rice (R) in normal years in Mali.

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Field clearing	M M	M M M M	M M M	M							
	S S	S S S S	S S S								
Ploughing			R R	R R R R	R						
Seedbed preparation		M M	M M M	M M M M	M						
			S	S S S S	S S						
Seeding				M M M M	M M M	M					
				S S S	S S S	S S S					
					R R	R R R					
First weeding, thinning					M M	M M M M	M M M				
				S S	S S S S	S S S					
							R R R R	R			
Second weeding					M M	M M M M	M M M				
					S S	S S S	S S S S				
								R R R R	R R R		
Harvest								M M M	M M M	M M	
								S	S S S S	S S S	
										R R	R R R

Adapted from: Comara, Amadou 1988.

Table 2. Mammal pests of rice in Côte d'Ivoire.*

		Stage attacked				
Zoological name	Common name	ST	BH	M	Forest	Savanna
Thryonomys swinderianus	Grasscutter		X		4	2
Xerus erythropus	Western striped ground squirrel	X	X	X	4	2
Mus minutoides	Pygmy mouse	X		X	4	3
Praomys tullbergi	Mouse/rat	X		X	2	2
Hylomyscus simus (=*alleni*)	Mouse/rat	X		X	3	2
Mastomys erythroleucus	Mouse/rat	X		X	4	4
Lophuromys sikapusi	Mouse/rat	X		X	2	3
Lemniscomys striatus	Mouse/rat	X		X	2	3
Rattus rattus	Rat	X		X	4	3
Arvicanthis niloticus	Mouse/rat	X		X	2	4
Phacochoerus spp.	Warthog	X	X		1	4
Erythrocebus patas	Monkey			X	1	1
Bos indicus (=*taurus*)	Cattle			X	0	3
Hippopotamus amphibius	Hippopotomus			X	1	1
Cephalophus spp.	Duiker	X			1	2
Tragelaphus scriptus	Bushbuck	X			1	2
Lepus crawshayi, *Poelagus marjorita*	Hare, rabbit	X			1	2
Syncerus caffer	Buffalo	X			1	0

0 = absent
1 = rare
2 = often found
3 = common
4 = abundant

ST = Sowing/tillering
BH = Booting stage/heading stage
M = Maturity

* Source: Becker and Diallo (1992).

Table 3. Trapping results on the WARDA research farm, M'bé, Côte d'Ivoire, from 1600 hr April 8 to 1600 hr April 9, 1992.

	Lowland area		Upland area	
No. traps	Nocturnal period	Diurnal period	Nocturnal period	Diurnal period
Sprung	7	0	1	0
Unsprung	42	58	17	18
With Rodent	9	0	2	0
With Toad	1	0	0	0
Missing	0	1	0	2
Total	59	59	20	20

Table 4. Measurements of rodents snap-trapped from WARDA research farm, M'bé, Côte d'Ivoire, April 8-9, 1992.

				Mean length (mm)				
Species	No.	Sex	Mean wt (g)	Total	Head & body	Tail	Hind foot	Ear
Mastomys[1]	5	Male	44.6	222.8	113.4	109.4	24.6	16.4
	4	Female	42.8	219.0	114.3	104.8	23.8	16.5
Lemniscomys	0	Male	---	---	---	---	---	---
striatus	1	Female	37.0	245.0	113.0	132.0	28.0	--[2]

[1] One *Mastomys* sp. was completely devoured by ants, leaving only skeleton and loose pelage; it was not included here.
[2] Both ears were scavenged.

Table 5. Measurements of *Mastomys* sp. snap-trapped from a screenhouse at the WARDA research farm, M'bé, Côte d'Ivoire, April 8-9, 1992.

				Mean length (mm)				
Species	No.	Sex	Mean wt. (g)	Total	Head & body	Tail	Hind foot	Ear
Mastomys sp.	2	Male	43.5	215.5	106.0	100.0	24.0	15.5

APPENDIX I

POSITION PAPER ON RODENT OUTBREAKS AND THEIR INCLUSION IN THE USAID DISASTER PREPAREDNESS AND MITIGATION (DPM) PROGRAM FOR NIGER

The DPM Program is a plan to reduce the impact of recurring disasters in Niger through early warnings and appropriate responses. Disasters that periodically occur in Niger and the Sahel include drought, famine, disease epidemics, and insect and rodent outbreaks. Smaller scale emergencies occurring locally within Niger will also be included. The plan will be developed using nonproject assistance and more traditional project assistance to increase USAID's flexibility in responding to emergencies and to decrease the constraints that impede the Government of Niger in responding to disasters. The program will also "seek to mitigate some of the conditions leading to food insecurity."

Rodent Pest Problems in Niger

The rodent problems in Niger appear to be similar to Chad. Seeding of millet or sorghum when rains begin in May, June, or July is affected by *Gerbillus* sp. and irrigated rice and winter vegetables are affected by *Arvicanthis* sp. Also *Praomys* sp. and *Taterillus* sp. are present and damage crops. Crops and the damage caused by rodents follow seasonal rainfall patterns which are fairly predictable. However, major rodent outbreaks are a result of lengthy dry periods of 2-4 years followed by normal rainfall for one or two seasons. During this lengthy drought, the factors that keep rodent pests in check are reduced. When rains return, rodent pests reproduce at rapid rates unchecked by natural factors that normally maintain rodent densities at reasonable levels. Usually after a 2-year period, these natural factors (predation, disease, competition) return and regular seasonal population levels occur. Rodent outbreaks take several months to develop and monitoring rodent population levels can easily detect the beginning of outbreaks. This offers an opportunity for early warning and gives ample time to assume that materials and logistics are in place to deal with this disaster.

If effective control measures that deal with specific rodent damage problems are available, rodent outbreaks should require only minimal preparation. Unfortunately, effective control measures are not in place in most of the Sahel. Therefore, an effort should be made to increase national operational programs that reduce the annual, chronic field damage that, over the years, is more substantial than that which occurs during major outbreaks.

Needs

Effective control measures against the primary rodent pest problems need to be determined in Niger and probably several other Sahelian countries. Once efficacy is verified, specific recommendations for control need to be published, extension workers and farmers trained, and materials necessary for rodent control made available through the private or government sector. Most likely, to accomplish this, some research and a substantial amount of

training needs to be done. The results of the USAID Rodent Control Research Project in Chad will provide useful information to West African farmers with similar rodent problems.

Regular monitoring of rodent populations in several key areas of Niger and other countries should be initiated and a network established to share the results in a timely manner. Monitoring techniques need not be complicated, time-consuming, or expensive, but rather simple, so that it can be easily maintained. Monitoring rainfall and general weather patterns also will provide information to predict rodent outbreaks within specific countries or regions. Within Niger, assuring that useful materials, such as rodenticides, are locally available to farmers will do a lot to eliminate delays--a common problem associated with outbreaks.

<u>Summary</u>

To avoid a potential disaster during the next rodent outbreak, Niger needs to (1) establish a monitoring program for early warning, (2) determine appropriate control measures for major rodent/crop problems, and (3) assure that materials are locally available to farmers and trained extension workers. Results from the USAID/DWRC/Chad Rodent Control Research Project should be widely circulated in Niger because of the similarity of the rodents and crops involved.

TRIP REPORT*

BANGLADESH

Vertebrate Pest Research and Project Administration

March 28-April 11, 1992

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Wildlife Biologist/Chief

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Unpublished Report

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ITINERARY

Date	Location	Activity
Mar 28-30	Denver, Colorado, to Dhaka, Bangladesh	Travel
Mar 30-Apr 9	Dhaka, Bangladesh	Meetings, discussions, and briefings with Bangladesh Agricultural Research Institute (BARI)/Vertebrate Pest Section (VPS), U.S. Agency for International Development (USAID), Bangladesh Rice Research Institute (BRRI), and Ministry of Agriculture (MOA)/Department of Agricultural Extension (DAE) on past and future research, extension, temporary duty assignments (TDY's), budgets, training, and general project implementation until June 1993
Apr 9-11	Dhaka, Bangladesh, to Denver, Colorado	Travel

ABSTRACT

The principal objectives of this TDY were to (1) verify the 1992 TDY schedule and begin planning the 1993 schedule, (2) determine the funds available and prepare a budget for in-country project expenditures, and (3) assess the current status of BARI/VPS research. These objectives and a number of other project activities were accomplished.

BACKGROUND

The Denver Wildlife Research Center (DWRC) has provided full-time in-country technical assistance to BARI/VPS from 1978 to 1990. Dr. Michael Jaeger, the most recent project leader, returned to the United States in August 1990, after which project support was to be continued with TDY's. These TDY's had been identified in 1990 and related to testing, implementing, and evaluating an annual rodent control strategy directed at rats during their lowest population period and developing longer term research plans for rodents, jackals, and birds. However, due to a number of delays, technical assistance was only reinitiated in November 1991. The project is due to end in June 1993.

During 1992 the DWRC and the VPS will be involved in (1) planning for the 1992 rodent control campaign which, if successful, may lead to a policy change in rodent control by the Government of Bangladesh (GOB), (2) implementing five TDY's related to project administration, wildlife statistics, predator and rodent research, and (3) planning research, training and extension activities for the remainder of the project. The purpose of my TDY was to determine with the VPS how best to implement these activities.

TDY SCHEDULE

The following TDY schedule was reconfirmed and is in progress. Formal Government of Bangladesh (GOB) and AID/Dhaka clearance have been obtained for all TDY's through July 15, 1992. Dr. Karim has provided verbal clearance for the October 1992 TDY.

Dr. David Saltz	Wildlife Statistician	Princeton University	Apr 9-May 1
Dr. Charles Harris	Predator Research Specialist	Idaho Fish & Game	Apr 14-May 16
Mr. Joe Brooks	Wildlife Biologist	DWRC	May 2-Jun 16
Dr. Jeffrey Jackson	Wildlife Extension Specialist	University of Georgia	Jun 15-Jul 15
Dr. Michael Jaeger	Wildlife Biologist	DWRC	Oct-Nov

Although a TDY schedule for 1993 was previously prepared and approved, it will likely be modified once TDY's for 1992 are completed to better reflect overall project needs and goals during its last 6 months.

RESEARCH

The VPS has maintained an active research program since October 1990 when DWRC full-time technical assistance ended. The following research has been conducted under a research program that is annually submitted to BARI with further financial support through the PL 480 mechanism:

(a) Rat and jackal damage assessment in 25 km^2 in Sripur
(b) Livestock losses to vertebrate predators in Sripur
(c) Bird damage assessment in maize in Joydebpur
(d) Carbamate insecticides to reduce bird damage in millet

This research will be reviewed during upcoming TDY's to determine its acceptability for publication and/or (if appropriate) modify the experimental design for additional investigations.

Research in progress includes:

(a) Rat glue development
(b) Rodenticide evaluations
(c) Bird repellents to sown seeds

VPS also was heavily involved during December 1991 and January 1992 in field evaluations of the 1991 Rat Control Campaign. VPS and the Department of Agricultural Extension (DAE) are now in the process of tabulating and entering the data into the computer for analysis. Dr. Saltz, currently on TDY in Bangladesh, is helping with data entry and analysis, and will also provide suggestions for improving future evaluations.

Future research plans for 1992 and beyond will be outlined for jackals during Dr. Harris' TDY and possibly birds during Mr. Brooks' TDY. Options to fund this research include annual PL 480 budget submissions by VPS, special PL 480 proposals, or PL 480 contracts.

BUDGETS

All unobligated project funds available from the various Project Implementation Letters (PIL's) for in-country support to the VPS Project were identified. After discussion with Dr. Karim, other VPS scientists, Mr. Habibur Rahman (AID), and with overall concurrence for the plan by Dr. Ray Morton (AID), these funds were tentatively budgeted to support the following activities:

Training

Bowling Green State University International Short Course in Vertebrate Pest Management (May-June 1992)

Western EcoSystems Technology
Sampling and Analysis of Biological Populations, Denver (January 1993)

Equipment

Air conditioners
Tires for vehicle
Computer

Construction

New rodent holding facility
Renovation of existing laboratory and office facility

Funds for the rodent holding racks and cages already have been obligated. Costs for renovating the jackal holding pens and the aviary will be sought through the PL 480 mechanism. An official training request letter for participation by Mr. Habibur Rahman and Mr. Emdad Haque for the Bowling Green State University Short Course in 1991, and for Dr. Karim for the Wildlife Workshop in 1992, was prepared and submitted to AID.

If the project facilities are to be completed by June 1993, it is important that the construction of the rodent holding facility and renovation of the existing laboratory/office building be initiated soon. Dr. Karim has agreed to provide estimates for this work (and for the jackal and aviary enclosures) to AID by the end of April. AID agreed that it would have its engineers evaluate the planned construction estimates on site. Most VPS facilities (with the exception of the outdoor rodent pen enclosure) have received little attention during the past 6 years.

TRAINING

Based on discussions with VPS, Ministry of Agriculture, DAE, and AID, there apparently is a need for and interest in providing technical training in rodent control to DAE Subject Matter Officers (SMO's), Plant Protection Senior Instruction (PPSI), and Agriculture Extension Training Instructors (AETI)--a total of about 450 to 500 individuals. This training was identified as important in the Pilot Study on extension capabilities conducted in 1989 by Mr. Santosh K. Sarker as part of his Ph.D. program at Dhaka University. While no concrete plans have yet been formulated, the following ideas were discussed for its implementation:

Site:	BARI Joydebpur or possibly regional locations
Coordinator:	BARI Director of Training and Communication
Time:	February-March 1993
Duration:	6 weeks; 50 people each for 3 days
Presenters:	VPS scientists and selected Bangladesh and DWRC resource personnel
Funding:	Major portion provided through PL 480 funds

If this training is identified as critical to the effective implementation of the National Action Plan for rodents in further discussions during the TDY's of Mr. Joe Brooks and Dr. Jeffrey Jackson, then a proposal to acquire the necessary funding needs to be prepared and submitted so that a commitment for funds can be obtained by September/October 1992 at the latest. DWRC will cover external technical assistance TDY costs.

PUBLICATIONS

DWRC and VPS Project scientists are in the process of preparing a number of documents for publication. The titles and status of each are listed below. Everyone concerned would like to see that these documents are in advanced stages of publication by June 1993.

Haque, E., and R. K. Pandit. In Press. Vertebrate pests and their control (in Bengali). Bangla Academy, Dhaka, Bangladesh.

Haque, M. E., J. E. Brooks, R. K. Pandit, and S. Ahmed. In Press. Farmers perceptions of the jackal (*Canis aureus*) as an agricultural pest in Bangladesh. Crop Protection.

Sultana, P., and M. M. Jaeger. In Press 1992. Control strategies to reduce preharvest rat damage in Bangladesh. Proceeding California Vertebrate Pest Conference.

Ahmed, S., R. K. Pandit, and J. E. Brooks. Submitted. Postharvest losses in farm houses in Bangladesh: rodent population estimates and potential food grain losses. Denver Wildlife Research Report Series.

Brooks, J. E., M. W. Fall, M. E. Haque, and R. K. Pandit. In Preparation. Immobilization of golden jackals with ketamine.

Haque, E., and R. L. Bruggers. In Preparation. Note on zinc phosphide analyses.

Haque, E., and M. M. Jaeger. In Preparation. Jackal censuses in Ishurdi area (radio-telemetry on jackal at Ishurdi).

Pandit, R. K., M. M. Jaeger, and M. E. Haque. In Preparation. Factors influencing the responsiveness of golden jackals to broadcasted howling.

Sarker, S. K. In Preparation. Evaluation of rodent control practices of Bangladesh farmers. Ph.D. Thesis.

Sultana, P. In Preparation. Developing a strategy for extending rodent control technology to the Bangladesh farmer.

Sultana, P., and M. M. Jaeger. In Preparation. Impact of jackal predation on preharvest rat damage in Bangladesh.

In addition, data from the following research projects will be reviewed during FY 92 and evaluated for appropriateness as VPS technical reports or publications:

Pandit, R. K., M. E. Haque, and M. A. Karim. Estimation of livestock losses due to vertebrate predators.

Pandit, R. K., M. E. Haque, and M. A. Karim. Rodent and jackal damage assessment of sugarcane.

Rahman, M. H., and P. Sultana. Bird damage assessment in maize.

Uddin, M. B., M. A. Karim, and P. Sultana. Efficacy of three carbamate insecticides in controlling bird damage to fox-tail millet.

OTHER ACCOMPLISHMENTS

1. Reviewed the following two Ph.D. theses, both of which are to be submitted to Dhaka University for completion during 1992:

   Sarker, S. K. In Preparation. Evaluation of rodent control strategies in Bangladesh.

   Haque, E. In Preparation. Biology, ecology, and control of the short-tailed mole rat, *Nesokia indica* (gray), in Bangladesh.

2. Discussed equipment and reprint/document needs with each scientist, and prepared a list for external purchases by DWRC. Purchases and shipments are in progress. All equipment purchased by DWRC is being maintained on a master list which can be verified during transfer of project equipment to VPS at the end of the project.

3. Discussed, reviewed, and updated the Bangladesh section of the 1990-1991 DWRC Annual Report to AID. It should be completed by July 1992.

4. Visited the jackal research area near Sripur.

5. Helped prepare a contract for a driver hired by AID to assist DWRC TDY'ers between March 28 and July 15.

6. Discussed with AID and VPS overall project concerns such as (1) communication among VPS, DWRC, and AID, (2) the need for Mr. H. Rahman to visit the VPS at least monthly to keep abreast of project activities and needs, (3) the division status for VPS, (4) the recent resignation of former counterpart scientist Dr. Parvin Sultana, (5) the current status of Ph.D. candidate Mr. Yousuf Mian at Colorado State University, and (6) ideas for continuing technical assistance after June 1993.

CONTACTS AND ACKNOWLEDGMENTS

U.S. Agency for International Development (USAID)/Dhaka
Agriculture and Rural Development, Office of Food and Agriculture

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Ms. Helen Gunther, Deputy Chief
Dr. Ray Morton, Program Officer
Mr. Habibur Rahman, Program Officer

Bangladesh Agricultural Research Institute (BARI)/Vertebrate Pest Section (VPS)

Dr. Md. Abdul Karim, Chief Scientific Officer, Head, Division of Entomology
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Mr. Habibur Rahman, Scientific Officer, VPS
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Ministry of Agriculture (MOA)/Department of Agricultural Extension (DAE)

Mr. Santosh K. Sarker, Rodent Control Specialist

Bangladesh Rice Research Institute

Dr. Sayed Ahmed, Senior Scientific Officer

* Dr. Parvin Sultana is now a private consultant in Bangladesh.

TRIP REPORT*

A review of study design, statistical analysis, and computer applications at the Vertebrate Pest Section of Bangladesh Agricultural Research Institute

BANGLADESH

April 9-29, 1992

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Unpublished Report

June 18, 1992

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ITINERARY

Date	Location	Activity
April 9	Departed New Jersey	Travel
April 10	Arrived London	Briefing with Dr. R. Bruggers
April 12	Departed London	Travel
April 13	Arrived Dhaka	On duty, Bangladesh
April 28	Departed Dhaka	Travel
April 29	Arrived New Jersey	Travel

SUMMARY

The Bangladesh Agricultural Research Institute was visited to provide computer and statistical assistance to the Vertebrate Pest Section. Computer software problems were solved and software updated. Guidance to local researchers was given in study design, statistical analysis, and use of SAS PC software. Answers from the evaluation questionnaire of the national rodent control campaign given to 320 contact farmers were analyzed. The data suggest that the campaign has an overwhelming impact with most farmers responding to it and practicing rodent control. The majority of the farmers thought the campaign did reduce rat damage to crops. Future work should concentrate on controlled studies of the actual impact of the campaign on the rat population, and the correlation between the farmers' perceptions of changes in rodent damage and the actual damage inflicted by rodents.

OBJECTIVES

The objectives of this TDY were to provide statistical and computer assistance to the Vertebrate Pest Section (VPS) at the Bangladesh Agricultural Research Institute (BARI). This TDY was based on Mr. Lynwood Fiedler's (1992) report and stresses the following scope of work:

I. Renewing SAS programs software, upgrading MS-DOS to 5.0, upgrading WORDPERFECT to 5.1, and providing access to the Hard Disk Management software on the IBM-PC computer system at BARI.

II. Establishing standard operating procedures for data entry and analysis.

III. Reviewing the 1991 data from the National Rodent Campaign and recommending appropriate changes for future evaluation.

IV. Reviewing the data from 1991 and research proposals for 1992 studies on rodents, birds, and predators, and recommending appropriate sampling and analyzing procedures.

V. Reviewing the 1991 DAE countrywide sampling scheme for assessing rodent damage in aman rice and recommending appropriate improvements.

VI. Advising on other statistical problems encountered in wildlife research.

The time frame set for this TDY was 3 weeks, but due to external limitations only 2 weeks were spent in Bangladesh.

ACTIVITIES

I. COMPUTER SOFTWARE: UPGRADE AND MAINTENANCE

The computer at BARI is an 80286 IBM PS/2 50 with a 60 MB hard disk and mathematical coprocessor. Diagnostics reveal possible problems with the keyboard and one of the ports. If problems start popping up with these, the machine will have to be serviced. Presently the machine is working fine.

The machine was infected by a virus (Dark Avenger strain) several months ago. The virus was removed using Central Point Anti Virus (CPAV) software. The software was obtained temporarily from a different source. On arrival I installed the CPAV version I had brought with me, and checked out the hard disks for any viruses. Presently the system appears clean. I removed TNTVIRUS (TNTVIRUS is actually an older version of CPAV before the software was bought by Central Point), and replaced the TSAFE memory resident program with VSAFE in the autoexec file. VSAFE senses any attempts by software to write themselves to memory or to disk. This provides an alert against potential viruses. It also will detect any changes in dates of executable files. This results in false alarms when software is updated. A message saying "the date on the file has been changed" appears on the screen and asks you if you want to continue. I installed WP 5.1 and DOS 5.0 instead of just upgrading to prevent this from happening. If it does happen, the source needs to be determined (if an executable was updated, etc.). If the source is unknown, run CPAV.

Updating the SAS version and plugging in the new contract was not easy. A 'not enough memory' message as well as file loading errors prevented the execution of SAS, SAS ZAP, and SETINIT. It took some time before I figured out that all or most of the SAS executables had been violated by the virus or during the cleanup process. Downloading SAS from the tape backup solved the problem. If the machine is infected again, and if SAS has problems running after the cleanup, repeat this process. The SAS version was updated, the new expiration date was entered, so all is now running.

The Mountain Tape backup unit and software work just fine. Initially it did have a memory problem similar to SAS but it seemed to sort itself out. There are 3 tapes. On one the old D: drive is backed up. This drive has the original version of SAS before the virus infection. I left this tape untouched. A second tape has been opened,

and originally I thought it had the C: drive on it, but it is damaged and can not be reformatted. I used the third virgin tape to back up the new C: drive with the DOS 5.0. The new D: drive still has to be backed up. A few more virgin tapes should be purchased.

When I upgraded to DOS 5.0, I left DOS 4.0 on the disk, and it is backed up on a floppy labeled Uninstall in the 3.5" disk bin. DOS 4.0 can be easily reinvoked with this disk if any problems due to the change in the operating systems come up (it is still on the D: drive in a DOS directory, while version 5.0 is in C:\DOS). This also allows BASICA to be invoked (DOS 5.0 uses QBASIC) so the data input program installed in 1990 by Ms. Paige Groninger (DWRC) can still run.

All the items on the menu developed by Ms. Groninger execute just fine. I added two more items (No. 10) to run DOS-SHELL (I assume this is what Mr. Fiedler meant by Disk Management software), and (No. 11) for the Lotus 3.1 version that VPS has obtained. Lotus 3.0 was not removed at the request of Mr. Rajat Pandit (VPS), but should be when VPS personnel feel comfortable with 3.1.

The hard disk is nearly full. Disks have to be cleaned out periodically. Files no longer in use tend to be left on and take up room. This may eventually cause problems with SAS which uses the hard disk to store temporary work files. Consideration should be given to removing WordStar and looking for other files and directories that can be removed. If you have no problem with DOS 5.0 over the next few months, remove the DOS directory on the D: disk (DOS 4.0), but leave BASICA. Software packages will continue to grow and a new or additional hard disk may eventually be needed.

The Rodent Control Campaign data can not fit on a single Lotus file. Lotus can use expanded memory. It may be worth it to purchase 1 MB of memory.

Recommendations

(1) The staff currently working at VPS has very limited computer and statistical skills (see below). SAS is a package for people who are fluent with computers and have a good understanding of statistics. It is an extremely powerful package, but is also user unfriendly. From what I understand, AID support and DWRC technical assistance will end in 1993. There is little doubt in my mind that unless someone at VPS receives extensive training in statistics and computers, SAS will never be used again after 1993. In 1989 DWRC looked into several options for providing SAS training to VPS (Appendix A). If this machine is to remain at VPS, and if there are no plans to assure someone at VPS becomes fluent in SAS through such training, I strongly recommend SAS be removed and a menu driven program like STATGRAPHICS be installed.

(2) A single person should be put in charge of the computer and computer room. This person will be in charge of maintaining the computer, backing up the hard drives, periodically cleaning the hard disk, and running the antivirus once a

week. This person should have a good understanding of DOS, other software, stats and SAS, and should have some background in hardware. No one in VPS is currently capable of doing this job. I don't know how Mr. Yousuf Mian is doing at Colorado State University, but it may be wise to talk to his advisor, Dr. Gary White, and ask him if he thinks Yousuf is capable of doing this kind of work. This does not mean he has to be able to develop statistical tests, just have a basic knowledge in general linear models, SAS, and PC maintenance. Discuss with Dr. White and Ms. Groninger possible methods of giving him such training.

(3) A user friendly graphics program such as HARVARD or FREELANCE is recommended. SAS/GRAPH is cumbersome and often requires too much memory for a dot matrix to print out. A menu driven graphics program will make it possible for the researchers at VPS to produce publication quality graphs.

(4) Install a second hard disk, or upgrade to a 120 MB hard disk. If SAS is left on the computer, more hard disk space will be required. Currently there are just a few MBs left. Lotus 3.0 and DOS 5.0 can eventually be removed. I left the General Operating Procedures because there was not enough room to accommodate them all on the hard drive. The VPS should explore the associated costs with the Dhaka vendor.

(5) RUN CPAV ONCE A WEEK TO DETECT VIRUSES BEFORE THEY SPREAD!!!!

(6) Install 1 more MB of RAM so Lotus can handle bigger files.

(7) Plans to renovate the VPS, which include expanding the size of the computer room, should be pursued. In the meantime the computer room is in dire need of a shelf. Presently books disks and manuals are thrown all over the place and are being ruined.

II. STANDARD OPERATING PROCEDURES FOR DATA ENTRY AND ANALYSIS

The staff at VPS has limited understanding of how variables are defined, and the relationship between independent and dependent variables. This results in poorly constructed data files. The following examples were found when I began to analyze some recently collected data:

(1) Data are entered in tables rather then columns, i.e., each farming block is placed in a table rather than the block number being a variable placed in a column.

(2) Summaries are done by hand and the means entered into the spreadsheet. In this manner information is lost.

(3) Different responses in single class variables are placed in different columns, for instance, a column for YES and a column for NO.

I have worked with Mr. Rajat Pandit on these issues and I think he is beginning to understand the concept. I explained to him about the need to enter data in the most concise form possible that will result in no loss of information.

Recommendations

There is a need for continued work on these issues with VPS staff. These can be summarized in several pointers:

(1) While designing the study, make sure they understand the questions and how they intend to answer them. Specifically, what are the independent and dependent variables being measured, and what kind of values can each variable receive. The type of statistical analysis should be considered already <u>at the designing stage</u>, and should be included in the proposals.

(2) Data should then be entered in Lotus (SAS FSPRINT can be used as well, but Lotus is the more flexible) with each variable in one column. A single row at the top should contain the variables names.

(3) If all values of a variable are mutually exclusive (for instance, in response to the question "Did you control rats this year?" a farmer can answer YES or NO but not YES and NO), the variable receives a single column. To more complex questions where several answers may apply, it is better if answers are ranked by their importance and each rank is then a separate variable (see recommendations below concerning the National Rodent Control Campaign).

(4) The Lotus files can then be translated using Translate option in Lotus into DBASE III files. These can be imported into SAS. Errors in translation from Lotus into DBASE are often caused by:

- nonempty cells outside the data range. This can be solved by using Worksheet Delete Row and Worksheet Delete Column from the edge of the data to the end of the spreadsheet (i.e., cleaning out those areas of the spreadsheet that do not contain the data).

- missing data in the first record. Lotus needs all cells in the first record (first line after the variable names) to be full so it can determine the type of variable before translation into DBASE. If that cell happens to be empty due to missing data, Lotus cannot assign a format to that variable resulting in an error message. This can be solved by supplying the correct format to that specific cell using Range Format.

III. NATIONAL RODENT CONTROL CAMPAIGN

The purpose of the rodent control campaign questionnaire is to evaluate the success of the campaign in reaching the farmers and getting them to actively control rat populations, and to evaluate the way the farmer perceives the success of the campaign. The key word here is 'perceive'. It is important to realize that a reduction in rat damage perceived by farmers does not necessarily mean it is due to control activities, or even that a reduction actually occurs. To answer these questions it is necessary to carry out a controlled study, which was the purpose of the countrywide damage assessment that was to be implemented immediately following the 1991 campaign.

The questionnaire study has several parts: questionnaires for supervisors at the district, upazila, and block level; a questionnaire for contact farmers; and a questionnaire for noncontact farmers. To date, only data from the contact farmer questionnaire has been put on disk, and therefore the analysis and conclusions described below relate to, and only to, the contact farmers.

This section will be divided into four parts:

Part 1. 1991 Questionnaire: description of the questions and possible answers presented to the farmer, and the way the data set was structured for analysis.

Part 2. Results of my data analysis, and conclusion. I must point out that interpretation of any results is best if done by the people who designed the study, since they know best what it is exactly that they are looking for.

Part 3. Recommended changes for next year's questionnaire and methodology of data input.

Part 4. Controlled studies needed to validate the campaign results.

Part 1. 1991 QUESTIONNAIRE

	QUESTION	POSSIBLE ANSWERS
1	Did you hear of the rat campaign?	Yes, No
2	From who did you hear of the rat campaign?	b=block supervisor c=contact farmer d=drum e=poster h=cinema hall m=loudspeaker n=paper o=union p=public r=radio s=neighbor t=TV u=local administration
3-1	Did you control last year and if so where?	F=field H=house B=both field and house N=no control
3-2	What control methods did you use?	1=poison 2=trap 3=digging up burrow 4=flooding burrow 5=other
4	Did you control this year?	Yes, No
4-1	How many rats did you kill?	Numeric
4-2	How many tails did you hand in?	Numeric
5	Who helped you?	1=block supervisor 2=contact farmer 3=neighbor 4=student 5=union member 6=relative 7=nobody

6	Did you get training, and if so by whom?	b=block supervisor c=contact farmer j=public/neighbor m=up member n=newspaper o=poster p=plant protection inspector r=radio s=student u=upazila office/SMO v=agric. field worker none=no training
6-1	Did you receive any of the following?	A=advice B=material help C=financial help D=encouragement
7	Did you use poison this year, and if so what kind?	zn=zinc phosphate m=Ratom®[1] ln=Lanirat® kl=Klerat® r=Racumin® g=gas tablets p=poison bait x=Phostoxin b=Bidrin® u=? none=no poisoning
	Where did you get the poison?	d=dealer s=shop/bazaar o=upazila office c=canvasser
8	What is the best control method?	psn=poison tab=gas tablet trp=trap wat=flooding bit=direct hitting oth=other
9	How was damage this year compared to last?	Lower, Higher, Same

[1] Reference to trade marks does not imply endorsement by the U.S. Government.

10	Do you think the rat control is effective? If 'YES' Why? If 'NO' why?	Yes, No A=because advertisement made me understand the importance C=crop was saved D=decreased rats F=furniture saved I=for integrated control K=Lanirat given for Agril. Rehabilitation L=less rats than last year T=got training and understood problems W=as there was wheat for rat tails E=no economic or material help given Tn=no training given Ni=no integrated control measures taken
11	How should rat control be carried out?	Communally, Individually
12	Should the rat control campaign be year-round? Why?	NO=do not control year-round A=awards for controlling rats C=crop saved D=decreases rat numbers F=as paddy remain in he field I=rat damage can be controlled by integrated effort N=control should be done while paddy in the field P=as population increase in field Y=damage is year-round
13	What is the best month for rat control in aman fields?	Va=Vadra As=Awsin Ka=kaetik Og=Ogrohayon
14	Which month is damage greatest? Why?	Va=Vadra As=Awsin Ka=kaetik Og=Ogrohayon P=Poush R=ripen paddy in field, field dry D=field is dry, only N=no food for rat except aman paddy F=floating water hyacinth in the field/emerged pinnacle H=do not know the reason W=make nest, cut pinnacle

15	What other things do you need for better rat control campaign?	1=training 2=good poison 3=cash 4=prize

In several cases answers were not completely clear to me. In all cases where answers could be joined into one variable, they were. For instance, Question 3 consisted of several parts: 'Did you control?' and 'Where did you control?'. I made a single variable of this question receiving different values for the different places of control, and a value for no control.

Part 2. DATA ANALYSIS AND INTERPRETATION

Results of my analysis are presented in Appendix B and are referred to by the page number displayed on the lower right-hand side of the appendix. Since most of the data was categorical, contingency tables were the main statistical method used. Tests were carried out whenever I thought they were necessary. In many cases results were clear cut and did not require any testing.

Three hundred and fourteen (98%) of the contact farmers interviewed heard of the campaign (Page 1 Appendix B). Of these 238 (77%) heard of the campaign from the block supervisor alone, and 47 from the block supervisor and other sources (Page 2 Appendix B). Thus, the block supervisor appears to be the most effective method to reach the contact farmer; the effectiveness of any of the other methods is negligible. A majority of the farmers practiced some form of control last year (91%), most concentrating their control in the fields (Page 3 Appendix B), and 15% controlling only around the house. Sixty-five percent of the farmers used 1 or 2 methods of control (Page 4 Appendix B). Poison alone or poison combined with another method was the overwhelming method used for control (Pages 5,6 Appendix B).

In 1991, 301 farmers (94%) practiced some form of control--a 3% increase in comparison to 1990 but not a significant one ($P = 0.0557$). The 19 farmers that did not practice any control did not appear to be concentrated in any one district (Pages 7-9 Appendix B).

There is a lot of variance in the number of rodents reported killed and the number of tails handed in (Pages 10-15 Appendix B). The number of tails handed in was significantly ($P < 0.0001$) less than the number of rodents reported killed. More data are needed to understand the sources of this variance.

Most farmers (>95%) got help from one source or another (Pages 16, 17 Appendix B). Most help came from the block supervisor (88.7%) with some help from neighbors (16.6%). Less than 10% of the farmers received help from other contact farmers, students, union personnel, or relatives. Most of the training was provided by the block supervisors (64.7%). Other sources had a minor contribution to training (Page 18

Appendix B). Almost 20% received no training at all. The districts where training was limited are listed on pages 19-20 of Appendix B, and possibly more effort should be invested in these districts. There was no significant difference ($P > 0.05$) between trained and untrained farmers in their perception of damage and campaign effectiveness (257 and 163 of the 269 trained farmers thought the campaign was effective and that damage was reduced this year, respectively; 46 and 28 of the 49 untrained farmers thought the campaign was effective and that damage was reduced this year, respectively). Most farmers received advice and encouragement (Page 21 Appendix B), but few (25) received material help, and only 4 received financial help. Financial help was not considered important to improving the campaign by two-thirds of the farmers (see below).

Seventy-five percent of the farmers used poison in 1991. Most used zinc phosphate or Lanirat, 97% of which was purchased either from a dealer or at a shop (Page 22 Appendix B). There was no significant difference ($P > 0.05$) in damage perception between farmers that used poison and farmers that did not (Pages 23, 24 Appendix B). Overall, poison or poison and trapping were considered by the farmers to be the best control methods (Pages 25-27 Appendix B), but there were significant differences ($P < 0.0001$) between districts in method preference (Pages 28-35 Appendix B).

Three hundred and three farmers thought the campaign was effective. The most common explanation was that the crops were saved. Of the 17 farmers that thought the campaign was not effective, most thought it due to no integrated control measures and no economic help (Page 36 Appendix B). An overwhelming majority of the farmers (97.5%) thought control should be carried out communally rather than individually (Page 37 Appendix B). Most of the farmers (88.4%) thought control should be implemented year-round because damage is year-round (Page 38 Appendix B).

Kaetik and Ogrohayon were considered the best months to control (Pages 39-41 Appendix B), but preference changed significantly ($P < 0.0001$) between districts (Pages 42-49 Appendix B). Damage was considered greatest during Kaetik and Ogrohayon, but this varied between districts as well. Fields being dry with ripening of paddy was the most common reason given for the months selected (Pages 50-56 Appendix B).

Farmers considered more training (88%) the most important factor in improving the campaign. Good poison (73%) and prizes (64%) were also considered important, while cash (33%) was the least preferred (Page 57 Appendix B). Here too, choices changed significantly ($P < 0.004$) between districts (Pages 58-65 Appendix B).

Part 3. RECOMMENDATIONS FOR NEXT YEAR'S QUESTIONNAIRE

Generally the questionnaire provides the information needed to determine if the campaign is successfully reaching the farmer. A few improvements can be made for the 1992 questionnaire.

(1) Data input should follow the guideline given in the recommendation section of Part II of this report. Generally the data base should be similar to the .SSD file I prepared this year so comparison between years can be made.

(2) In questions requiring a choice of the best of several possible answers, farmers should be allowed to choose only one, or if more then one answer is given the farmer should rank the answers from best to worst.

(3) There is a difference between missing values and 0. A code for missing values should be used across all variables--a string code such as 'miss' for string variables, and a number code such as '0.9999' for numerical data. Blank cell in Lotus will be translated as 0 into SAS.

(4) Similar answers to different questions should have the same code.

(5) I was informed that parallel to the questionnaire, counts of rat burrows were conducted in each of the upazilas. The counts were not necessarily in the fields of the farmers questioned. In the future burrow counts should be done in the fields of the farmers questioned. This will enable a correlation between the farmers' perception of the rodent problem and the actual abundance of rodents.

(6) Mr. Fiedler suggested selecting fields with high damage for future campaigns. I strongly discourage this for several reasons. First, there are still no data on the causes and patterns of spatial and temporal variation in rodent damage between fields. A field with high damage this year may have low damage next year regardless of control. Second, damage levels in fields with high damage are more likely to decline due to random chance alone regardless of control. It is just like choosing a roulette table that has just produced the number 36 and testing if some trick will cause the next number to be lower. **Fields should be selected randomly**, or stratified randomly (i.e., select fields with low, medium, and high damage).

Part 4. CONTROLLED STUDIES

(A) Determine poison effectiveness at different densities of rodents. Such a study may be difficult as it would require convincing certain farmers not to implement any control.

(B) Determine the accuracy of farmer damage estimates. This must be done by providing farmers with placebos instead of real poison.

IV. REVIEW OF RODENT, PREDATOR, AND BIRD DAMAGE STUDIES

The general progression of research by VPS should be carried out in four stages as follows:

(1) Quantify the amount of damage inflicted on crops, and identify the species inflicting most of the damage.

(2) Determine the level of variation in damage between the different areas, and try to correlate these variations with various factors.

(3) Test if generating such a condition artificially reduces damage.

(4) Implement pest control and assess its effectiveness in terms of cost and benefits through controlled studies.

(5) Assess the inter- and intraspecific density dependent responses of the pest species to the control methods.

RODENT AND JACKAL DAMAGE TO SUGARCANE

Stage (1) of this study has already been carried out. The use of the sugarcane nodes rejected by the farmer due to rat or jackal damage is probably the best method to assess damage because it quantifies directly the amount of loss realized by the farmer. Regretfully only one field was sampled per block with one replication per field. Thus there is no replication to enable testing between blocks. From my brief study of the data it appears that there is high variation in damage between the blocks, but with no replications this cannot be tested. In any case, the cause for this variation should be investigated. Initially, this should be done by collecting data and running correlations, and then verifying the results through controlled studies to determine if these factors can be used to control damage.

The high variance in the data also reduces the confidence in the overall estimated damage. An accepted 95% confidence interval should be predetermined, and based on the variance, the sample size needed to obtain the confidence level should be calculated.

I do not believe there is a need for a study in the pens on the comparative efficiency of jungle cats and jackals as potential controllers of the rat populations. There is no evidence that they do control the population, and the pen study will not determine if they do. Furthermore, these animals prey on livestock and probably bring more harm than benefit. This can be assessed by comparing the sugarcane damage data with the farm predation data (below). Also, by combining the data sets it may be possible to determine if there is a correlation between jackal damage to sugarcane, their predation on livestock, jungle cat predation on livestock, and rat damage. Such correlations may suggest that by reducing the number of rats without controlling jackal populations they

may revert to feeding on livestock, or consuming more sugarcane. I am sure the energetic requirements of jackals are documented in the literature, and by assessing population density (a rough maximum density estimate from home range studies would be sufficient), it would be possible to determine how many rats jackals would consume per unit area if they fed only on rats. I believe this number will be very small compared to the standing rat populations. If predator control occurs, it is usually at low prey densities. The fact that rat populations grow rapidly after their reduction in numbers during the rainy season suggests that jackals have a limited impact on their dynamics.

FARMER QUESTIONNAIRE ON LIVESTOCK LOSSES TO PREDATION

I prepared a SAS file of these data and gave it to Dr. Harris. I reviewed SAS with Dr. Harris, and he and Rajat will be analyzing the data.

The questionnaire targeted 10 farmers/block in 25 blocks of 1 km^2. The data set has several drawbacks. First, it relies on the farmer to determine the species of predator, and second, the number of living livestock given are for the time of interview not time of predation. The latter can be corrected in next year's questionnaire. Correlation between neighboring blocks should be investigated and the effect of the presence of dogs should be looked at.

BIRD DAMAGE TO CORN FIELDS

The data collected by Mr. Habibur Rahman so far have no replications within each field and have a limited number of fields. No data were recorded on potential predictor variables of the damage. Thus, not only is it impossible to look at potential correlates to damage, even the estimated level of damage is poor. The study should be targeted at assessing the level of damage to corn fields and what determines the level of damage.

I spoke to Mr. Rahman about this and recommended the following factorial design:

Factor 1: Fields.
  Categorize corn fields by factors that potentially affect bird behavior (presence of trees, water, etc.).
  Choose n (at least 5) fields from each category.
Factor 2: Locations.
  Determine damage along the perimeter of the field and in its center.
  Measuring unit = level of damage to a 10-m section of a corn row. Randomly select 20 10-m sections from each field (10 from the perimeter and 10 from the center). Note that these are <u>repeated measures</u>.

V. <u>THE DAE COUNTRYWIDE SAMPLING OF AMAN RICE</u>

I met with Mr. Santosh Sarker. The work is still not completed.

VI. ADVISING ON OTHER STATISTICAL PROBLEMS

The short duration of the TDY and the need to analyze the Campaign data left little time for instructing. I worked with Mr. Pandit on setting up data sets so they can be analyzed by SAS, and instructed him and Dr. Islam (Entomologist) on bringing data into SAS using Lotus files translated into DBASE file and running PROC DBF. I also went through PROC FSPRINT using the options NEW and EDIT. I demonstrated Freelance on my notebook and they both seemed very interested.

Mr. Pandit seems to be comfortable with WP and Lotus, but needs much more training in statistics and SAS before he will be able to use SAS effectively. Dr. Islam has a good understanding of SAS and statistics and could give VPS some help when needed.

Mr. Rahman has literally no statistical background. I spent a few hours with him trying to explain the importance of sample size and confidence intervals and offered a study design for his bird damage project (see above). He as well as all VPS scientists should be encouraged to locate and participate in statistical workshops.

CONCLUSIONS

Dr. Ray Morton has expressed two goals of the AID program at VPS: (1) training of staff so that they will be able to perform on their own once the program is terminated, and (2) getting Bangladesh farmers to actively control rodent populations. The data from the campaign suggests it has been very successful and that farmers realize the importance and benefits of their control efforts. There is little doubt that rodent pest control will become standard practice with farmers. By contrast, the staff at VPS needs much more training. Unless a single person who has a good understanding of design and analysis is found or trained, research at VPS will never get beyond general descriptive studies. There is a great need for long-term research planning, and training of the researchers to think in terms of these plans to assure that innovative research in pest control will not come to a standstill when the AID project is terminated. Clearly a mechanism is needed to permit occasional, timely consultation between external researchers and VPS after June 1993 if possible improvements to pest control are to be realized.

Appendix A

SAS TRAINING--Options For VPS Scientists (Source Ms. P. Groninger, DWRC 1989)

(1) Having SAS send someone to Bangladesh. When I was in Bangladesh I thought there might be enough interest in SAS from several sources that there could be enough people to make this cost-effective. It would probably take 20-25 people, however, because it would take many thousands of dollars to provide this type of training. Also, when SAS provides training, they usually provide the computers to do the training on. That might prove a problem in Bangladesh. It would have to be coordinated through the closest SAS subsidiary to Bangladesh, so right now a lot of questions are unanswered.

(2) Computer-based training.

Computer-based training allows the user to sit at the computer and follow instructions on the screen. A course guide is provided to assist with the training.

There are 7 computer-based courses available. They are available through a license agreement that would cost $195/course for the first year and $95/course for each succeeding year. However, if you license 6-7 courses, there is a 15% discount. That is very cheap training.

(3) Video-based training.

Video-based training uses videotapes to provide the training instructions. Workbooks and diskettes with practice data files and programs are also provided.

There are 9 courses available for the video-based training. They are provided on a license basis, ranging from $1000-$2000/course for the first year, and $750-$1500/course for each succeeding year. There are discounts available for licensing multiple courses. Because there are more courses, more subjects are covered.

SAS also has several video tutorials, which are sold, not licensed. They cost $195/course; additional copies are $95 each. There are discounts available for multiple purchases. However, these tutorials are for more experienced SAS users and do not cover the SAS basics.

I have discussed all of these options with the SAS Institute; they suggest that the most cost-effective training would be the computer-based training. SAS is sending me a course outline and demo diskettes with samples of the computer-based training. We can look at it here, and send it to Bangladesh, to get opinions.

Appendix B[1]

Printout of Actual Data from Questionnaire Survey

of Contract Farmers Relative to the

1991 National Rodent Control Campaign

[1] Printout of this data was provided to VPS only.

TRIP REPORT*

REVIEW OF 1991-1992 PREDATOR RESEARCH

BANGLADESH

April 14 - May 16, 1992

by

Charles E. Harris
Wildlife Biologist
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for

International Programs Research Section
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Animal and Plant Health Inspection Service
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Unpublished Report

June 2, 1992

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ITINERARY

Date	Location	Activity
14 April	Departed Boise	Travel
	Arrived Denver	Met with Dr. Rick Bruggers
	Departed Denver	Travel
16 April	Arrived Dhaka	On duty, Bangladesh
14 May	Departed Dhaka	Travel
16 May	Arrived Boise	Travel

SUMMARY

The principal objectives of this TDY were to: 1) review progress of 1991-1992 predator research on jackals, particularly damage assessment in sugarcane; 2) advise on enclosure studies designed to measure the predator capacity of jackals and jungle cats on rodents; 3) review draft manuscripts on jackal research; and 4) plan a research program for 1992-1993. Manuscripts were prepared on "Rat and jackal sugarcane damage assessment in Sripur Upazila, Bangladesh" and "Estimation of livestock losses to vertebrate predators at Sripur Upazila, Bangladesh". Continuation of ongoing pen studies to measure predation capacity of jackal and jungle cat was not recommended. Research for 1992-93 should: 1) continue to refine methodologies of sugarcane damage assessment to reduce or accurately document the existing high variability; 2) assess the effects of some simple animal husbandry practices on predation losses; and 3) conduct a series of pen feeding trials on jackal and jungle cat to provide input into recently developed computer models that can determine the biomass of prey taken by predators, which in turn can be used to address various questions and concerns regarding predation effects on rats, livestock, and crops.

OBJECTIVES

The objective of this TDY was to meet with Vertebrate Pest Section/Bangladesh Agricultural Research Institute Scientific Officers to review the predator research activities conducted in 1991 and to date in 1992. Specifically I was to:

I. Review progress of 1991-1992 predator research on jackals, particularly damage assessment in sugarcane.
II. Advise on enclosure studies designed to measure the predator capacity of jackals and jungle cats on rodents.
III. Review draft manuscripts on jackal research.
IV. Plan a research program for 1992-1993.

ACTIVITIES

I. <u>Review progress of 1991-1992 predator research on jackals, particularly damage assessment in sugarcane.</u>

A. Rat and jackal damage to sugarcane in Sripur:

I reviewed the 1990-91 BARI Annual Research Programme progress report and used it as the basis for drafting a manuscript entitled "Rat and Jackal Sugarcane Damage Assessment in Sripur Upazila, Bangladesh." The comparison of weights of damaged and undamaged sugarcane internodes allowed direct measurement of the amount of rat and jackal damage and subsequent economic losses. The drawback to this technique is the considerable amount of time it takes to collect such data. This is probably tied to the next problem of small sample sizes (25 fields), no replication of samples (fields) within 1-km^2 blocks to look at variability among fields within blocks (which was very high), or samples within fields to look at the variability within fields caused by the clumped distribution of rat burrows (hence clumped rat damage) and potential differences in distribution of jackal damage. The high variance and standard deviations reduces the confidence in the damage estimates and the subsequent comparisons made in the statistical analysis. Such high variability in damage may in fact be true, but without replication this will not be known.

In reviewing the field data forms I noticed that only differences in weight of the damaged and undamaged internodes were recorded rather than the actual weights of each internode. This precluded the calculation of some valuable statistics (% weight loss and % sugar loss) which were commonly reported in other references and hence useful for comparing this with other research. Original weights need to be recorded if this type of research project is repeated.

Data analysis was done using SAS. Because of the unequal sample sizes in the variables (variety of sugarcane, standing or bent canes, proximity of fields to houses) the ANOVA procedure in SAS printed a warning message about the unequal sample sizes and recommended using the general linear models (GLM) procedure. I ran ANOVA and printed out the SAS program statements and wrote comments on the output so Mr. Rajat Pandit would have them for future reference if he needed to run an ANOVA on another data set. I then ran GLM and comparison of means tests, printed the SAS program statements, wrote comments on the output, and reviewed the analysis with Mr. Pandit. The data files I created to run on SAS were saved for future reference or analysis.

<u>Recommendations:</u>
1) Develop clear objectives to be achieved and research hypotheses to be tested regarding rat and jackal damage to sugarcane. This should lead to the development of an appropriate experimental design with <u>replicate</u> measures (fields within blocks; samples within fields) to test the hypotheses. The statistical analysis to be used needs to be known and understood before data collection and computer data entry begin. For

data analysis in SAS (or any other statistical package) one needs to have an understanding of the differences between class (independent) variables and response (dependent) variables. Both Dr. Saltz and I emphasized these points to the VPS scientists.

2) Review the various methods that have been used to collect sugarcane damage data to find one that provides reliable data that can be collected in an efficient manner given the time and budget constraints of the VPS staff. A nondestructive method that allows sampling over time would be desirable to look at when damage occurs and how it may change during the growing and harvest seasons (i.e as some fields are harvested, jackals move to adjacent fields potentially increasing damage). Mr. Joe Brooks brought a recent publication with him detailing a repeated sampling methodology used in Hawaiian sugarcane research that may prove useful. Having never worked with sugarcane, I do not know how difficult it may be to repeatedly sample a growing sugarcane crop once it gets to a certain height or density such that the logistics of moving through it and collecting data becomes exceedingly difficult. Mr. Pandit feels that repeated sampling during the growing season throughout a sugarcane field would be very difficult.

B. Livestock losses to vertebrate predators at Sripur:

I reviewed the 1990-91 BARI Annual Research Programme progress report and used it as the basis for drafting a manuscript entitled "Estimation of Livestock Losses to Vertebrate Predators at Sripur Upazila, Bangladesh". Due to the nature of the data there was very little in the way of analysis to be done other than summary statistics. I condensed the 7 predation tables in the progress report into a single table for ease of comparisons and reduced space.

<u>Recommendations</u>:
1) Losses of goats and kids to jackals, and chickens to jackals, jungle cats, and raptors were quite substantial in the 1991 survey. A question in the survey regarding whether or not farmers used any animal husbandry practices that may have affected predation losses (e.g. cooping chickens at night, tending or tethering kids/goats, presence of dogs) would have been useful as a starting point for explaining possible differential losses and developing some testable hypotheses. However, hypotheses regarding potential affects of animal husbandry practices on predation losses can still be developed and tested. Ideally one would like to randomly assign treatments (cooping chickens, not cooping chickens) to a random sample of farmers in the Sripur area to see whether or not the null hypothesis of no differences in predation losses would be rejected. The reality of working in the field and getting the cooperation of the farmers may yield less than the ideal, but such an experimental design should be attempted for proper analysis, interpretation, and potential expansion of the results beyond the Sripur area. Other variables that may be important to or correlated with predation losses are time of year (livestock losses tended to increase during the monsoon season; Haque et el. 1984), availability of alternate prey or food sources (Sultana and

Jaeger 1989), rodent abundance, rodent control, levels of crop damage by rats and jackals, etc. The concepts of compensatory mortality and competing risks also come to mind as something to watch for, i.e. chickens saved from jackal or jungle cat predation by cooping at night may be lost to raptors during the day if allowed to roam freely.

II. <u>Advise on enclosure studies designed to measure the predator capacity of jackals and jungle cats on rodents.</u>

Although documenting predatory behavior and predation rates of jackals and jungle cats would be interesting, I do not believe this is a pressing research need of VPS nor will it clarify the relative impacts these two predators have on rodent populations or Bangladesh farmers. The null hypothesis of such an experiment would be something on the order of H_0: predation rates (rats killed per hour) of jackals and jungle cats are equal. To test this hypothesis one would initially need to determine the number of independent trials needed to detect a difference at a given alpha and level of power. Is it feasible to think of using, for example, 25 different jackals and 25 different jungle cats at each of several different levels of rat density to test for differences in predation rates within and between predator species at the various levels of rodent density that may be encountered in the field? And if H_0 is or is not rejected, how does that relate to what happens in the field, those predator and prey populations to which you wish to extrapolate your pen findings. Would it make any difference if it takes a jungle cat in the field 2 hours to catch its daily energy requirements of 250 grams of rats compared to 4 hours for a jackal to catch its 500 grams if there is no indication that rodent (or prey) biomass is a limiting factor.

When predator studies get to the point of looking at differential predation rates and predation efficiency between predators it is usually because there is some evidence that the predators may be competing with each other for a limited prey resource with implications for both the predator and prey populations. I do not think such a case can be made at this point for jackals and jungle cats. Most previous studies designed to assess the impacts of predators on prey populations have been inconclusive and lack the necessary experimental controls essential for comparison.

A question of interest would be what proportion of the rodent population is being taken by the various predator populations, are there any population limiting or regulating factors operating, is there any relationship between predator/prey population levels and livestock predation losses and crop damage. The Sultana and Jaeger (1989) model demonstrates a potential beneficial effect of jackal predation on rats in wheat fields by reducing rat damage, but does not suggest any limiting effect of jackals on rat populations. Does intensive rat control reduce population levels to a point that there is an effect on predator population levels or behavior (increased predation on livestock) as may be indicated by the seasonal increase in livestock losses during the monsoons (Haque et al. 1984).

III. Review draft manuscripts on jackal research.

I reviewed a very early draft manuscript of "Factors Influencing the Responsiveness of Golden Jackals to Broadcast Howling". The technique holds some promise as an index of jackal abundance. However, many factors contributed to variation in response rates which will necessitate refinement and consistent application of the data collection procedure if the technique is to result in a viable index. The best time to conduct the survey appears to be winter during early evening hours. However, the variable "brightness of the moon" was not as readily discerned as to a preferred survey time because group size of 1 responded more on darker nights whereas larger groups responded more on brighter nights (Tables 5 and 9 in the above manuscript).

As an attempt at some sort of validation of the methodology, it would seem worthwhile to decide on a standardized survey procedure and repeat the survey of the Sripur area to see if the predicted responses hold up. Also the survey should be conducted in areas that have already been established as having relatively fewer jackals (Mirzapur) versus more jackals (Ishurdi) based upon scat deposition rates (Sultana and Jaeger 1989). This may not be perfect validation of an index against a known population, but it may be useful to the same extent that scent station indices from south Texas (higher coyote densities) are higher than those in Montana (lower coyote densities).

For publication of this paper it would be preferable to reduce the number of tables (most editors and reviewers will not like lots of small contingency tables). One possibility would be to make a table showing which of the factors and interactions were or were not significant (showing P values and n where appropriate such as the g-test results in Tables 7b-11b) or print the information in the text as is requires less journal space and expense than tables.

IV. Plan a research program for 1992-1993.

Previous VPS research has shown predators cause losses to livestock and agricultural crops in Bangladesh (Haque et al. 1984, 1985; Poche et al. 1987; attached reports by Pandit et al. 1992) as well as potentially reducing crop damage by predation on rodents (Sultana and Jaeger 1989). Future research by VPS should continue to objectively assess problems and potential benefits of predators to Bangladesh farmers and provide options to handle identified problems. The research should be based upon understanding predator biology and behavior as it relates to improving the efficacy, efficiency, and selectivity of damage prevention and control.

Sugarcane damage by rats and jackals: It may seem redundant to continue with the sugarcane damage research, but a scientifically sound and efficient methodology for assessing damage to sugarcane by jackals and rats needs to be identified and implemented by VPS to be able to monitor changes in damage that may occur in response to management programs or natural events. An improved experimental design is required to assess and hopefully reduce the variability observed in the present study so as to define levels of detectable change, i.e. given the variance in damage itself, the sampling variance, and variance

in measuring the damage, how small a change in damage can we detect with the chosen monitoring system, 10%, 50%, 100%? What level of change is needed to be detectable? Refer to recommendations listed above under I.A.

Livestock depredations: Attention should be given to whether implementing modest and relatively inexpensive changes in animal husbandry practices (e.g. putting solid secure doors on pens and coops of goats and chickens) can reduce predation losses to jackal, jungle cat, and raptors. Refer to recommendations above under I.B.

Jackal and jungle cat predation:

Understanding a species food habits and feeding ecology is a fundamental component of understanding the relationships of a species and its environment. Food habits of jackals in Bangladesh have been described by analysis of stomach contents (Poche et al. 1987) and scats (Sultana and Jaeger 1989, Sarker and Ameen 1990). Several biases exist in the analysis of food habits and ecological relationships based upon frequency of occurrence of food items in scats, most notably they seldom accurately reflect the number and biomass of prey consumed. This can lead to false or inappropriate conclusions regarding the relative importance of a particular prey species in the diet, the impacts of predation on a prey population, predator/prey interactions, or interactions within a predator community. Such unreliable knowledge and false or misleading conclusions can lead to misguided management actions and programs that fail to solve the real or perceived problem.

Scat analysis biases have been evaluated by Kelly (1991) and predictive models developed that estimate the biomass of prey consumed represented by a sample of scats, an estimate of variance, and a sample size formula to determine how many scats to analyze. Four separate models (listed in order of preference for accurate results) are proposed based on: 1) the weight of prey remains recovered after a scat is washed, 2) the oven-dried weight of a scat before washing, 3) the average amount of prey represented per scat, and 4) an index of prey consumed.

VPS predator research can make a significant contribution to understanding the feeding ecology and predatory relationships of jackals and jungle cats in Bangladesh with some well designed feeding trials in the pens at BARI and a representative sampling of field scats. Feeding trials with known species and quantity of prey/food items provides validated ratios for input into the models with respect to the proportion of a scat attributable to a given species (equating of occurrence bias) and the amount of a given species represented by a scat (non-flesh component bias). These ratios allow the calculation of the biomass of prey consumed by a predator, e.g. how many kilograms of rat were consumed by the jackal or jungle cat population in Sripur in one year.

The feeding trials would require the collection of the various sized rodent species found in each predator's diet (Rattus, Bandicota, Mus); chicks, half-chickens, and adult chickens; and kids and goats. A sufficient sample size of each predator species would be fed predetermined meals of single species and multiple prey species combinations; fed all at once in large prey meals and

fed over a period of time in smaller meals that probably represents a more normal feeding pattern. Kelly (1991) describes the feeding trials in detail; a copy of his thesis was left at VPS for their review and study. The results of the jackal feeding trials could be compared with those of Kelly's (1991) coyote feeding trials as the species are very similar biologically and ecologically. Scats collected in the pens could also be used to help differentiate jackal and jungle cat scats collected in the field. It would be worthwhile to consult with Dr. Fred Knowlton (USDA/APHIS/DWRC) and Brian Kelly (former graduate student of Dr. Knowlton) in designing the feeding trials and determining the minimum sample sizes of predators and prey meals required.

A methodology will need to be designed for the collection of field scats, possibly in conjunction with other field work associated with sugarcane damage research and the surveys of farmers for predation losses (see above recommendations) as was done by Sultana and Jaeger (1989). Scats collected in the field can be compared with those from the feeding trials to compare detectability of prey species and how closely feeding trials mimic natural predation and feeding regimes.

Estimation of biomass of prey consumed will follow the feeding trials and collection of a sample of field scats. Modeling exercises like that of Sultana and Jaeger (1989) should be done to explore various possibilities of predator/prey interaction, to put livestock and rodent predation in proper perspective, and assess potential effects of rodent or predator control.

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Mr. Santosh K. Sarker, Rodent Control Specialist

TRIP REPORT*

Pakistan, Bangladesh, and India

Program Review, Rat Control Campaign Evaluation, and Cooperative Research

May 2-June 11, 1992

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Unpublished Report

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ITINERARY

Date	Location	Activity
May 2-4	Denver, Colorado, to Islamabad, Pakistan	Travel
May 4-7	Islamabad	Project evaluation
May 8	Islamabad to Dhaka, Bangladesh	Travel
May 9-29	Dhaka	Project evaluation
May 29-30	Dhaka to Calcutta, India, and Bangalore, India	Travel
May 30-June 3	Bangalore	Discussions on cooperative research
June 3-4	Bangalore to Delhi, India, Frankfurt, Germany, to New York	Travel
June 4-11	New York	Annual leave
June 11	New York to Denver, Colorado	Travel

SUMMARY

In Pakistan, the Vertebrate Pest Control Laboratory (VPCL)/National Agricultural Research Center (NARC) research and technology transfer program is functioning effectively. A 3-year budget request, consistent with workplans, has been submitted. Results of research have been submitted for publication. In Bangladesh, the 1991 National Rat Control Campaign reached about 800,000 farmers. An estimated 7,740 mt of rice were saved by killing over 1 million rats. Recommendations for improvement of the 1992 campaign are given. In India, several short- and long-term cooperative projects in Vertebrate Pest Management were investigated.

OBJECTIVES

The objectives of this TDY were: **Pakistan:** to evaluate current and future research, training, and technology transfer programs of the Vertebrate Pest Control Laboratory/NARC, Islamabad; **Bangladesh:** to evaluate the 1991 National Rat Control Campaign and make recommendations for improving the campaign during 1992, strengthen the postharvest component of the 1992 Campaign, and evaluate the quality, availability and cost of rodenticides; **Bangalore, India:** to explore the possibility of cooperative research between the University of Agricultural Sciences, Bangalore, and the Denver Wildlife Research Center (DWRC).

ACCOMPLISHMENTS

Pakistan

Vertebrate Pest Control Laboratory, NARC/Islamabad

The Denver Wildlife Research Center was involved in implementing an AID-funded project to strengthen vertebrate pest management research in Pakistan beginning in 1985. DWRC technical assistance to the VPCL ended in June 1991. The VPCL is continuing to conduct excellent field and laboratory research. The number of publications and works in progress is impressive (Appendix I). The present staff consists of A. Aziz Khan, Principal Scientific Officer, Iftikhar Hussain, Scientific Officer, Shahid Munir, Scientific Officer, Shamsul Kabir, Farm Attendant, Liaqat Ali Wahla, Laboratory Attendant, Mohammad Ilyas, Daily Paid Laborer, and Fateh Mohammad, Driver. Other drivers can be requested from the NARC motor pool as needed. Another Scientific Officer, Shakil Ahmad, is to be assigned to the VPCL, Islamabad, in July 1992.

The budget for the VPCL for the current year has been adequate. The program received Rs. 150,000 for 1991-92, which is just enough to conduct some field work but not enough to carry out all planned activities. A proposed budget for the next 3 years (Table 1) has been presented to the Pakistan Agricultural Research Council (PARC). Actually, if Rs. 200,000 were received for 1993, it would be adequate to fund almost all planned activities.

Table 1. Present and proposed budget for the VPCL/NARC.

Year	Salaries and benefits	Operational expenses	Capital expenses	Total
1991-92	Supplied from Karachi	150,000	------	150,000
1992-93	374,115	478,000	47,000	899,115
1993-94	388,517	539,000	63,000	990,517
1994-95	402,445	605,000	80,000	1,087,445

Note: At least 200,000 Rupees are needed for field and laboratory operations.

The workplan for 1992-93 calls for research in:

- Wild boar and porcupine control operations in agroforestry
- Identification of rodent pest problems in upland valleys
- Reproduction and diet studies of some rodent pests of the Potwar Plateau
- Evaluation of zinc phosphide wax blocks in paddy rice (S. Munir)
- Prevention of pest bird damage to sunflower
- Evaluation of the two-ingredient cartridge fumigation against porcupine
- Establishment of a wild boar management research institute at NARC
- Ecotoxicology studies on zinc phosphide (S. Munir)

VPCL scientists have published four papers in the last year, five more are in press or submitted, and two are in preparation (see Appendix I).

Copies of the Vertebrate Pest Management (VPM) training manual were distributed to Australia, Switzerland, Nigeria, Denmark, the United Kingdom, and the United States. Copies of the women's rodent training manual were distributed (100 to the Women's Foundation, Lahore). A VPM training course, the 8th, is planned between September and October.

A means of maintaining cooperative research and scientific exchange between DWRC and VPCL is needed, as much mutually beneficial work would result.

Bangladesh

1991 National Rat Control Campaign

A nationwide campaign of rat control was held in Bangladesh from October 15-30, 1991. The campaign culminated 3 1/2 months of campaign preparation, beginning in July 1991. Precampaign activities began with the training of the trainers at District level: Deputy Directors of Agricultural Extension (DDAEs) and Subject Matter Specialists (Plant Protection) (SMSs/PP). The training was done by the Department of Agricultural Extension (DAE)/Bangladesh Agricultural Research Institute (BARI)/

Bangladesh Rice Research Institute (BRRI) scientists. Training was given to all 64 DDAEs and 64 SMS/PP during a one-day workshop in each district. A booklet describing the measures to be taken during the campaign was distributed to all DDs and SMS(PP). A total of 40,000 copies were printed.

During the period from August until the campaign opened on October 15, the DDAEs and SMS(PP) gave training at upazila and block supervisor level. They distributed the rat control booklets, gave out 100,000 posters to be hung in public places, and distributed 400,000 farmers leaflets. Cinema slides were distributed (600 each of 2 slides) to cinema owners for showing. The DAE, Dhaka, also distributed posters, booklets, and leaflets to the Water Development Board, Bangladesh Railways, the Department of Roads & Highways, Education Department, and NGOs but gave no training to their personnel.

Articles on rats and rat control appeared in the September/October 1991 issue in Krishi Katha, the farmers agricultural magazine distributed by the Agricultural Information Service of DAE.

The campaign was inaugurated by the Minister of Agriculture, Major General M. Majid-ul-Haque (retired) on October 15, 1991. Coverage was provided by all daily newspapers.

The main message of the posters was that individual initiative is helpful for successful rat control. The posters further described July/August as the best time for rat control in houses and on embankments, and September/October as the best time for rat control in aman rice fields.

The campaign relies upon a hierarchy of agricultural extension officials to carry the message down to villager and farmer level (Fig. 1).

Central Headquarters DAE, Dhaka

District Deputy Director of Agricultural Extension (DDAE)
Subject Matter Specialist [SMS(PP)]

Upazila Upazila Agriculture Officer
Subject Matter Officer (Plant Protection)

Block Supervisors and Dealers

Contact Farmers, Noncontact Farmers
Villagers

Fig. 1. Hierarchy of agricultural extension officials for dissemination of information and training during the rat control campaign.

The farmers leaflet was complicated by a variety of messages. The primary message was "kill rats together." Other messages stated that rats damage crops and household structures, they transmit a variety of diseases, and villagers should work together to destroy rats in road embankments and field crops simultaneously, that a variety of control methods should be used, and that timing rat control before the booting stage in rice will be most effective. Finally, farmers were told to contact their block supervisor for further information.

During the campaign, several rodenticidal materials were available on the market to farmers wanting to poison rats. These included small packets of zinc phosphide, a not-yet registered (but applied for) formulated zinc phosphide product (a powder containing 3% zinc phosphide mixed with fried wheat and rice flour priced at Tk 7.00 for a 20-g packet), Lanirat®[1] (bromadiolone) whole wheat bait packets (100 g packet for Tk 12.00), Klerat® (brodifacoum) wax blocks (10-5 g blocks for Tk 10.00), and various aluminum phosphide tablets for burrow fumigation. All of the above active ingredients are registered for rodent control in Bangladesh. Zinc phosphide and aluminum phosphide were the materials recommended by the Action Plan for farmers to use.

Some statistics gathered by the DAE on the campaign:

Training: DDAEs: 64 received one-day training, SMS (PP): 64 received one-day training, Extension workers: 12,580 trained, and Farmers: 475,388 trained.

Rat tail competition: Total tails deposited in the 64 districts: 1,031,771. Highest rat tails for districts, Gopalganj, 242,323; Kishoreganj, 115,00; and Mymensingh, 32,079.

<u>Rat Control Campaign Evaluation</u>

The 1991 rat control campaign was evaluated by the Vertebrate Pest Section (VPS)/BARI and the Plant Protection Wing/DAE during December 1991 and January 1992. The evaluation was done by farmer interview and by inspection of rice fields for rat damage and rat burrows. A total of 320 contact farmers (CF) and another 320 noncontact farmers (NCF) were interviewed in 32 randomly selected upazilas.

It is difficult to evaluate the results of the interviews since target goals were not set by the campaign organizers. However, the importance of the Block Supervisors in the communication and training chain is indicated by the farmers' responses; 64% of CFs and 80% of the NCFs learned of the rat control campaign from this source (see question boxes below). Likewise, the Block Supervisors provided training to 75% of the CFs and 60% of the NCFs. All CFs were supposed to receive training, while NCFs attended training sessions voluntarily. The upazila office was the other important source of training. Only 5% of the NCFs heard of the campaign from the CFs. The upazila office and radio ran a distant second and third in communicating the news of the campaign. Posters and cinema slides were

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

mentioned by only 2 (0.6%) of the 320 contact farmers (CF) interviewed. None of the noncontact farmers mentioned posters or cinema. It was obvious that CFs and NCFs received their information from different sources.

Did you hear of the rat campaign?	CF	NCF
	Y 98%	Y 94%

Source: (%)	CF	NCF
Block supervisor:	64.0	80.0
Upazila parishad:	8.7	4.1
Radio:	8.1	5.9
Public:	1.9	0.7
Newspaper:	1.6	0.0
Television:	1.2	0.3
Drum beating:	0.6	3.8
Contact farmer:	0.6	5.0
Poster:	0.6	0.0
Cinema:	0.6	0.0
Neighbor:	0.6	1.6

Did you do rat control?

	1990	1991
CF	91%	95%
NCF	84%	90%

Did you receive any training?

	CF	NCF
	Y 85%	Y 66%
Source: (%)	CF	NCF
Block super.	75	60
Upazila par.	15	7
Contact farm.	0	3

Rat control in 1990 and 1991 was practiced by 91 and 95% of the CFs, and 84 and 90% of the NCFs, respectively. The increase was not due to an increase in rat numbers, which the farmers judged as lower in 1991 than the year before, but probably to an increased awareness created by the campaign.

Regarding rat control, 76% of CFs and 70% of NCFs did control in crop fields, while 58% of CFs and 52% of NCFs controlled rats in houses. Of the CFs doing control, 68% used poisons, 46% trapping, 37% watering (flooding burrows with water), and 33% dug up burrows and killed the rats by beating. Among NCFs doing control, 59% used poisons, 48% used traps, 29% used water, and 27% used digging.

Where did you do control? (%)

	CF	NCF
Field	76	70
House	58	52

What method did you use? (%)

	CF	NCF
Poisoning	68	59
Trapping	46	48
Watering	37	29
Digging	33	27

The most common poison was zinc phosphide, used by 43% of CFs and 29% of the NCFs who did control. Lanirat, an anticoagulant ready-mixed bait packet containing 0.005% bromadiolone, was used by 34% of CFs and 25% of

NCFs, which reflected its availability on the market. Ratom®, a ready-mixed bait of 3% zinc phosphide and fried wheat and rice flour, was used by 7% of the CFs and 11% of the NCFs. Racumin®, an anticoagulant containing coumatetralyl, was used by 3% of CFs and 6% of the NCFs. Aluminum phosphide gas tablets were used by 2% of the CFs and 8% of the NCFs. Eleven percent of the CFs and 10% of the NCFs did not know the poison ingredients in the baits they used. This situation should be addressed through the extension process in future campaigns.

Poison baits were regarded as the best method of rat control by 68% of the CFs and 59% of the NCFs. Trapping was next at 46 and 48%, respectively; followed by watering, 37 and 29%. CFs and NCFs differed on gas tablets, with 10% of NCFs saying it was a good method while only 0.5% of CFs agreed. Cats were preferred by 4% of CFs and only 1% of NCFs. About 2% of the CFs liked dogs and beating rats with sticks; very few NCFs agreed. Among NCFs 2.5% liked digging.

Ninety-five percent of the CFs said the campaign was successful; 90% of the NCFs agreed with this perception. The main reasons advanced for this success were that the crop was saved (CFs 50% and NCFs 46%), furniture was saved from damage (CFs 9% and NCFs 5%), the importance of controlling rats was understood (9% of CFs and 13% of NCFs), and the concept of integrated control was appreciated. The idea that the campaign decreased the rat population was a reason given by 5% of the CFs and 9% of the NCFs. Almost all (98%) of both groups agreed on an integrated, community approach to rat control.

Eighty-eight to 89% of all farmers said control should be done year-round because (1) rats damage crops and structures year-round, (2) crops must be saved from rat damage, and (3) rats need to be prevented from increasing. Only 4% said that control should be done only while the paddy is in the field. The month in which to have conducted control was from mid-October to mid-November, according to 38-41% of the farmers, because the damage was greatest in this time (48%). Other months were rated as less important because damage was less. Both findings are in contrast to the objectives of the National Action Plan, indicating that much more extensive input is needed.

The four most appreciated campaign activities were the training (32-34%), good rodenticides (28-30%), the prizes (22-25%), and the money (13-16%). Some disagreement over the abundance of rodents in 1991 was voiced by farmers. Sixty and 57% of CFs and NCFs felt that rat populations were less than last year, 27 and 25% thought populations were greater, and 13 and 18% reported similar populations.

Interviews with DDAEs and Upazila Agriculture Officers (UAOs)

Interviews on the effectiveness of the campaign were taken at district level from 16 Deputy Directors of Agricultural Extension (DDAEs) and at upázila level from 32 Upazila Agriculture Officers. The responses of the Upazila Agriculture Officers are summarized in the following question boxes.

Was the media used good?	
Y 18	N 14
Why not?	
Insufficient funds	6
Limited advertisement	4
Insufficient posters/leaflets	2
More meetings needed	1
No reason given	1

How many days were media used?	
Meetings	226
Cinema slides	166
Drum beating	167
Poster/leaflets	145
Microphone	75
Newspaper	3
Radio	0

The responses indicate that the media materials were generally good but that more funds were needed at upazila level. UAOs held meetings with farmers, gave out cinema slides, posters and leaflets, and created awareness with drum beating and microphones.

Upazila distribution of media	
Leaflets	33,578
Posters	4,522
Booklets	637
Slides	42

The UAOs worked with CFs, NCFs, upazila and union parishads and the schools and colleges on the campaign. They had little contact with the agencies that should have done rat control on roads and highway and railway embankments and with nongovernmental organizations.

What groups did you work with to implement the campaign?	Y	N
Contact farmers	32	0
Noncontact farmers	32	0
Upazila parishad	22	9
Union parishad	25	7
Schools & colleges	29	1
Roads & highways	2	22
NGOs	6	20
Bangladesh RR	0	26
WAPDA	0	26

The poisons available were zinc phosphide and Lanirat, while Racumin, Klerat, and aluminum phosphide gas tablets were not generally found. This probably accounts for why few farmers used them. Zinc phosphide and aluminum phosphide were the materials recommended in the Rodent Control Action Plan.

What poisons were available?	Y	N
Zinc phosphide	28	3
Racumin	11	20
Lanirat	29	2
Klerat	7	24
Gas tablets	3	28
Was bait supply sufficient?	3	28

The UAOs agreed with the farmers that rat problems, as compared to the year before, were lower this year (19/32), the same (8/32), or higher (2/32).

Interviews with DDAEs

In 16 districts, the Deputy Directors of Agricultural Extension were interviewed. In response to the question, "Were the media used on the campaign appropriate?" 10 replied, "Yes," 4, "No," and 2 gave no response. When asked why, two said the media materials were not sufficient, one said it was due to lack of funds, and one said more meetings were needed. Some other responses are given in the question boxes below.

How many days were media used?	
Meetings	168
Drum beating	163
Poster/leaflets	151
Cinema slides	240
Microphone	93
Radio	12
Newspapers	9

District distribution of media	
Leaflets	117,504
Posters	23,513
Booklets	5,314
Slides	277

What groups did you work with to implement the campaign?	Y	N
Contact farmers	16	0
Noncontact farmers	16	0
Upazila parishad	15	0
Union parishad	16	0
Roads & Highways	6	9
Schools & colleges	14	1
NGOs	4	9
Bangladesh RR	0	13
WAPDA	4	10

Were the poisons available?	Y	N
Zinc phosphide	13	3
Racumin	7	9
Lanirat	16	0
Klerat	6	10
Gas tablets	1	15
Was the supply sufficient?	4	11

Rat damage this year as compared to last year?	
Lower	10
Same	4
Higher	2

Burrow Counts

The field of every farmer interviewed was inspected for active rat burrows. Thus there were paired samples of fields taken in each block (10 of CFs and 10 of NCFs). This allowed a statistical comparison of the CFs with the NCFs, assuming some differences should be evident due to the training and other inputs the CFs received. Only part of the paired field samples could be used, since in some cases counts were not made, or the number of fields inspected was too small (1 to 5 fields each). In some cases neither fields had any burrows to count. A total of 43 paired samples was analyzed for statistical differences in burrow counts (Table 2). Only 6 of the pairs were statistically different, and 3 were lower counts for the CFs and 3 were lower in NCFs fields. The conclusion drawn from this is that there was no difference in burrow counts between CFs and NCFs.

These in-field burrow counts are one very important aspect of the post-campaign evaluation that needs to be strengthened and standardized for the 1992 campaign. The timing on making these counts is important; they should be done during the last few weeks of the aman rice harvest so that they are relevant to rodent damage to the rice crop.

Table 2. Burrow counts in fields of contact farmers and noncontact farmers.

	Mean burrows ± SD CF	NCF	T-test signif.		Mean burrows ± SD CF	NCF	T-test signif.
Suvadya	.6 ± .7	.3 ± .5	n.s.	Gopalganj	.6 ± .8	.6 ± .9	n.s.
Tegoria	.5 ± 1.0	.7 ± 1.1	n.s.	Block-Kha	.3 ± .7	.3 ± .5	n.s.
Narisha	.6 ± 1.1	.5 ± .8	n.s.	Babulia	1.0 ± 1.3	1.8 ± 2.0	n.s.
Kusumhati	.6 ± .7	.8 ± .8	n.s.	Madhobkhati	1.1 ± 1.6	1.0 ± 1.1	n.s.
Togorbonda	.5 ± .7	.5 ± .7	n.s.	Kulia	.7 ± .8	.7 ± .9	n.s.
Hamamdia	15.4 ± 7.2	36.8 ±14.7	<.05	Kalaia	2.1 ± 1.0	2.6 ± 1.3	n.s.
Gharua-I	2.4 ± 1.3	1.7 ± 1.9	n.s.	Ranipur	2.0 ± 1.0	1.9 ± .8	n.s.
Tarail	2.5 ± 1.6	4.4 ± 5.2	n.s.	Betagi	2.2 ± 1.0	5.0 ± 2.6	<.05
Ghonapara	.5 ± 1.6	1.8 ± 2.0	n.s.	Bamna-4	1.9 ± 1.8	1.1 ± 1.1	n.s.
Gopalpur	14.3 ±10.0	6.1 ± 3.2	0.05	Safipur	.9 ± 1.2	1.0 ± 1.4	n.s.
Baganpar	10.4 ±10.0	2.8 ± 1.6	0.05	Keboali	8.4 ± 9.2	6.0 ± 6.7	n.s.
C. Daspara	.3 ± .5	.2 ± .6	n.s.	Rajapur	24.4 ± 8.4	20.9 ±12.2	n.s.
Monicura	.3 ± .7	.4 ± .9	n.s.	Nolciti	15.7 ± 6.3	27.3 ± 9.4	<.05
Pakshi	1.3 ± 1.3	.3 ± .4	0.05	Molipur	26.4 ±20.4	14.1 ±12.1	n.s.
Muladuli	2.2 ± 2.2	1.2 ± 1.6	n.s.	Haitgao	7.4 ± 4.0	9.3 ± 4.3	n.s.
Vandaripara	.5 ± .5	.9 ± 1.1	n.s.	Vatkhain	.7 ± 1.1	.7 ± .9	n.s.
Kashita	.3 ± .5	.4 ± .6	n.s.	Gonakora	5.3 ± 2.5	5.7 ± 3.2	n.s.
Nowda	2.0 ± .8	1.7 ± .9	n.s.	Chorosladi	.7 ± 1.2	.5 ± .8	n.s.
Giridharipur	.5 ± .5	.8 ± .9	n.s.	Haludia	.7 ± 1.2	.5 ± .7	n.s.
Rampur	.7 ± .8	.8 ± 1.1	n.s.	Sosdanga	2.5 ± 2.5	1.0 ± 1.4	n.s.
Poursava	.6 ± .7	.8 ± 1.0	n.s.	Dribuapur	.5 ± .5	.4 ± .5	n.s.
Dipasha	2.5 ± 1.7	3.0 ± 1.3	n.s.				

Other burrow counts were done by Plant Protection Inspectors (PPIs) in the 64 districts but not all were reported. Table 3 lists the burrow counts by numbers per acre from 43 districts. The counts, overall, seem modest indicating a low rat population in most districts; high counts only from Pirajpur, Pabna, Sathkhira, Sirajganj, and Dhaka districts. This bears out the farmers contention that rat populations were less this last year than the year before.

Again, these burrow counts need to be taken during the last few weeks of the rice harvest. Comparisons need to be drawn between the counts taken in fields where farmers did rodent control and in those fields where farmers did no control.

Table 3. Rat burrow counts from farmers fields in districts in Bangladesh. (Data taken by Plant Protection Inspectors, DAE)

District	No. active burrows	Area (ac)	Active rat burrows/ac	District	No. active burrows	Area (ac)	Active rat burrows/ac
Narshindi	139	164.0	0.8	Sherpur	15	20.7	0.7
Bagahat	56	23.4	2.4	Magara	11	3.9	2.9
B.Bana	92	12.4	7.4	Jessore	1180	192.2	6.1
Bandarbon	144	43.8	3.3	Sunamganj	148	47.2	3.1
Mymensingh	223	42.2	5.3	Pabna	262	24.2	10.8
Chadpur	5	1.8	2.7	Sirajganj	225	24.9	9.0
Bhola	269	155.5	1.7	Rajbari	66	12.3	5.4
Khulna	119	81.2	1.5	Natore	28	23.2	1.2
Nowgoan	93	40.6	2.3	Sathkhira	427	25.7	16.6
Khagrasori	103	62.3	1.6	Dhaka	76	7.9	9.7
Rangpur	72	20.2	3.6	Gopalganj	75	20.4	3.7
Graibanthe	117	23.9	4.9	Dhakurganj	77	22.4	3.4
Pirujpar	213	17.6	10.8	Rangamati	49	30.3	1.6
Kirigram	155	31.8	4.9	Bargane	102	25.9	3.9
Kusha	13	10.2	1.3	Manikganj	89	18.0	4.9
Kishorganj	9	9.3	1.0	Dinajpur	43	41.3	4.9
Chuadanga	52	19.9	2.6	Habiganj	19	17.6	1.1
Rajshahi	206	65.5	3.1	Lakhipur	6	19.0	0.3
Nabaganj	13	21.6	0.6	Munriganj	94	14.3	6.6
Mederipur	1635	440.1	3.7	Joypaohat	55	20.5	2.7
Lalmonirhat	686	177.4	3.9	Noakhali	59	20.5	2.3
Tangail	14	10.9	1.3				

<u>Campaign constraints as reported by the DDAEs:</u>

(1) There was a lack of funds for mass media	37/64 dist.
(2) Free rodenticides and free traps were not available	13/64 dist.
(3) No incentives for rat tail collection	12/64 dist.
(4) Difficulties due to heavy rain	10/64 dist.
(5) High price of poison baits/poor quality	9/64 dist.
(6) No provision for district or upazila prizes	8/64 dist.

This year there will be additional funds for mass media and a provision for more prizes at district and upazila level. No attempt will be made to supply free rodenticides or traps, and no money for rat tails. The high number of rat tails returned from Gopalganj, however, was attributed to the nongovernmental organizations (NGOs) offering 50 paisha for each rat tail.

Campaign Achievements

(1) The 1991 campaign trained 12,580 extension workers in rat control, who in turn trained 475,388 farmers.

(2) A total of 1,031,771 rat tails were deposited. Many of these were rats dug out of burrows and killed with sticks or rats that were trapped. Some were killed with poisons. Although collection of rat tails is of dubious value to effective rodent control, it does serve the purpose of focusing farmers on control and bringing attention to a coordinated control approach.

(3) At least 800,000 farmers conducted rat control in 1991. Since 90-95% of the farmers interviewed practiced rat control, we can assume that 90% of the 475,000 did rat control and likely an equal number of nontrained farmers did also, giving at least 800,000 farmers practicing rat control in 1991.

(4) The amount of rice saved was 7,740 mt, worth $1.55 million. A total of 1,031,771 rats were known to have been killed. Each rat could have been expected to live another 100 days, assuming that half their life was already gone when they were killed (rats life expectancy is 6 to 8 months). Each rat damages 75 g of rice/day, or 7.5 kg in their 100 days. Killing 1.031 million rats in October 1991 saved 7.74 million kg, or 7,740 mt of rice.

DISCUSSION

Training is the most important component of the campaign, yet may be one of its weakest links. One-day training given to the DDAEs and the SMSs (PP) is passed down the chain of communication until it reaches farmers. The training given to the DDAEs and the SMSs, in all likelihood, is not the same training imparted to the farmers. Without some kind of standardized training materials, the spoken word becomes distorted as it is passed along. A small training manual, a well-illustrated booklet for farmers, and a series of audiovisual aids, such as video tapes, are needed by all the trainers so that training is standardized. Other than the campaign booklet, which basically describes how the campaign is to be organized and implemented, there was no other training material in evidence.

Video tapes can be shown anywhere a VCR and TV are available. A portable electric generator will provide a power source. Video tapes about rodents and rodent control in field crops can be understood by both the literate and the nonliterate farmer. They are interesting, much more so than a "canned" lecture. Two video tapes, one on rat control in rice and one on rat control in wheat, are available from the former Vertebrate Pest Management Project in Pakistan. While in Urdu, they could easily be re-dubbed for use in Bangladesh. Two other tapes should be made locally: one on rodent control on roadsides and embankments for personnel of Roads and Highways, Bangladesh Railways, Water Development Board, and Local Governments, and one on household rodent control for villagers and

farmers. Keyed to these videos there should be copiously illustrated booklets for those persons that are able to read. The illustrations also help the nonliterate. These videos and the accompanying booklets could be used in training at all levels, providing a standard level of training throughout the communication chain.

The question, "Does creating awareness and giving training lead to motivation?" needs to be answered. The campaign is predicated on this assumption. During the 1991 campaign the NCFs also did control without being directly targeted for training. Granted, many of them did voluntarily receive training. There is no question that the training that the Block Supervisors gave was very important in conveying information and awareness of the campaign. However, did the training motivate the farmers to take action? Only a properly developed, sociological study can answer this question.

The usefulness of the posters and the cinema slides as mass media to create awareness of the campaign is questionable since only 0.6% of the CFs mentioned these and none of the 320 NCFs mentioned them. Perhaps the use of these media in the 1992 campaign should be reconsidered and the funds used for other purposes.

The assumption that farmers will find available poison baits on the market was a good one since 77% of the CFs and 66% of the NCFs used them, finding them mainly at pesticide dealers and village shops. DAE should continue efforts to ensure that quality poison baits are available on the market throughout the country.

During the next campaign, an attempt should be made to evaluate the efficacy of the farmers who did carry out rat control. This is an excellent opportunity for the VPS and the DAE to jointly develop a statistically meaningful sampling scheme for determining the impact campaigns have on reducing rat damage, as proposed in the Action Plan. Interviews are a good start, but need to be followed by objectively obtained field data. A suggested study plan is given in Appendix II. If no significant reduction is achieved, then changes in strategy, rodenticide use, or extension practices are called for.

The next campaign should set quantifiable goals of accomplishment. The objectives of the campaign were clearly spelled out in the 1991 campaign, but no quantified goals were set. These are needed in order to evaluate the success of the 1992 campaign. All goals to be set can use the levels achieved during the 1991 campaign as benchmarks from which to exceed.

The timing of the campaign was not good. Since almost half of the farmers said that most rat damage occurs from mid-October until mid-November, the campaign did not take place in time to prevent this damage. If the campaign could start by mid-September, it probably would prevent much of the damage to the aman rice crop. It was the recommendation of the Action Plan for Rodent Control in Bangladesh that preharvest control in aman rice be done during September and October. There apparently has been no consideration of carrying out the postharvest campaign in July and August, as recommended by the Action Plan.

RECOMMENDATIONS

1. The campaign in the aman rice crop should be timed to start by mid-September and run until the end of October. Consideration should be given to holding the postharvest campaign in July and August, as recommended in the Action Plan.

2. Video training tapes should be prepared, one aimed at farmers and another aimed at personnel of railways, water development boards, and roads and highways. Ancillary materials, such as illustrated booklets, should accompany the videos. Copies should be distributed down to the Block Supervisor level throughout the country. Funds should be made available to Block Supervisors to rent VCRs and televisions, if needed. Copies should be provided to the Railway Division, the Water Development Board, and the Roads and Highways Department, for training their personnel.

3. The use of posters and cinema slides should be reviewed, since they were not effective in the 1991 campaign according to farmers' responses. Perhaps the posters were not hung or were hung in places where they were not regularly seen by the public.

4. A statistically meaningful campaign evaluation method needs to be developed and implemented by the VPS/BARI and the DAE to determine if the campaign actually reduced rat damage to the aman rice crop. This means some way of determining rat damage in the fields of farmers practicing control vs. those that did no control.

5. The next campaign should clearly spell out quantifiable goals to be achieved during the campaign. Only with these can the success of the campaign be measured. The strategy should be clearly laid out: what species of rodents are targeted for control (burrowing rats in fields or house-dwelling rodents), how the campaign will be carried out, what methods are to be used, etc.

6. The campaign evaluations should be done just before or during the harvest of the aman rice crop. The evaluation this year was done too late to do any damage assessments in farmers' fields. The evaluations should start by mid-November at the latest.

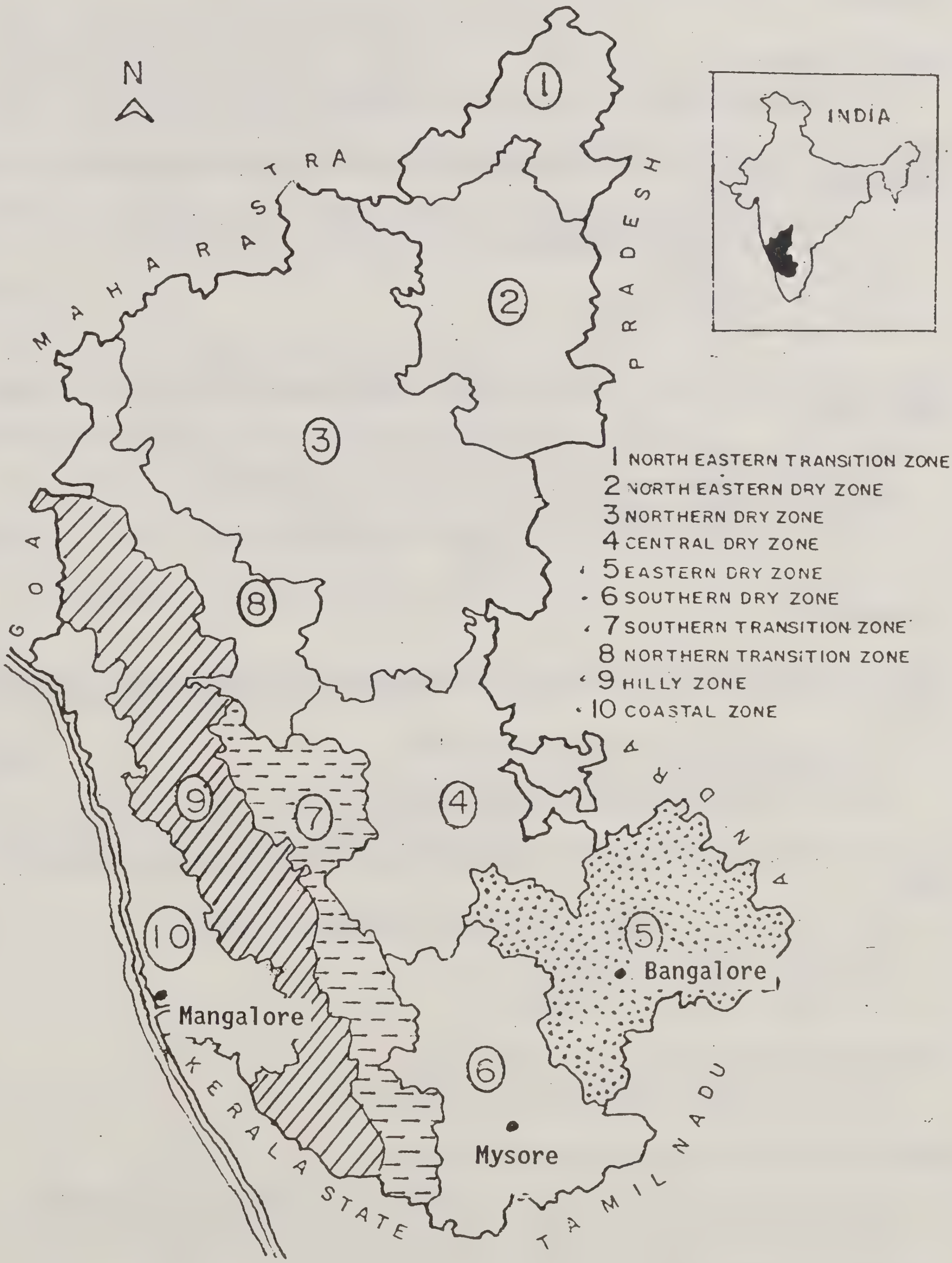
Bangalore, India

During March 1992, Dr. Shakunthala Sridhara visited DWRC and invited me to visit her research institute, when possible, to see firsthand India's vertebrate pest problems and discuss areas of potential cooperation. In Karnataka State, India, I visited the University of Agricultural Sciences (UAS), Bangalore, and five field research stations at Mandya, Mysore, Mudigere, Uppangala, and Vittala. The rodent research and control program at the UAS began in late 1973 under the auspices of a 3-year grant to the UAS from the Ford Foundation. A pilot project was carried out at the V.C. farm, Mandya, followed by a full-scale demonstration at three villages near Mysore. Drs. A. S. Barnett and W. B. Jackson served as consultants to the project while it was funded by the Ford Foundation. In October 1977, the project became part of the All-India Coordinated Research Project on Rodent Control. Research on rodent biology and behavior, toxicology, baits and bait shyness, development of rodent control techniques and strategies, and technology transfer have continued up to the present. The rodent research staff are housed at the new campus (1975) of the UAS, Bangalore. They have offices, a laboratory, and a new animal house. They lack computer capabilities, and the one project vehicle is about 10 years old and no longer used for off-station research.

The five research stations I visited lie in the irrigated and dryland agricultural zones, the southern transitional zone, the hilly zone, and the coastal zone (Fig. 2). The major crops grown are cereals (paddy, finger millet, sorghum, and maize), pulses and oilseeds (green gram, cowpea, groundnut, and sunflower), and cash crops (coffee, cardamon, cocoa, coconut, sugarcane, and fruits). The principal rodent pests are *Bandicota bengalensis*, *Tatera indica*, *Millardia meltada*, *Mus booduga*, *M. platythrix*, *M. musculus*, and two species of squirrels, *Funambulus palmarum* and *F. tristriatus*. The bonnet monkey (*Macaca radiata*) is a pest in maize, cardamon, and cocoa. Rose-ringed parakeets and crows are pests of maize, sunflower, and fruits. These are many of the same pests and agricultural problems faced by both Pakistan and Bangladesh so that previously developed technology could be readily implemented.

Discussions were held on possible short- and long-term cooperative research projects between the UAS and DWRC. A 5-year proposal to strengthen integrated vertebrate pest management at the UAS was developed. Work under this proposal would be done at field sites in Vittala, Mudigere, and Mandya. Several short-term projects also were proposed. Since monkeys should be controlled only with nonlethal means, we discussed the possibility of immunocontraceptives or implanted slow-release contraceptives. Squirrels are a major problem in cardamon. Several approaches were discussed, but it was obvious that more research on the breeding, movements, and behavior of squirrels is needed before a control strategy can be formulated. Damage assessments are needed in Karnataka in several crops: cardamon, sugarcane, cocoa, and maize. **In summary, the possibilities for cooperative research between the UAS and the DWRC are good if funding sources can be found. Both long- and short-term studies on vertebrate pest problems that have regional applications appear feasible.**

FIG. 2. KARNATAKA - AGRO-CLIMATIC ZONES



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APPENDIX I

MANUSCRIPTS AND PUBLISHED PAPERS OF THE VPCL, ISLAMABAD

Khan, A. A. 1991. Evaluation of four fumigants against the short-tailed mole rat, *Nesokia indica* Gray and Hardwicke, 1932. Trop. Pest Management 37:96-99.

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Asif, M. M., J. E. Brooks, and E. Ahmad. 1992. The diet of the lesser bandicoot rat, *Bandicota bengalensis*, in central Punjab, Pakistan. Pak. J. Zool. (In Press)

Hussain, I., M. M. Asif, J. E. Brooks, and E. Ahmad. Enhanced litter size in *Bandicota bengalensis* captured from wheat fields. (In Preparation)

Khan, A. A., I. Hussain, and S. Munir. Comparative evaluation of several rodenticides against rats in groundnut crops. (In Preparation)

Hussain, I., A. A. Khan, and S. Munir. 1992. Trapping success of PAROTRAP. Pak. J. Zool. 24(2). (In Press)

Hussain, I., S. Munir, and A. A. Khan. Responses of caged rose-ringed parakeets to methiocarb. Sarhad J. Zool. (Submitted)

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APPENDIX II

RESEARCH ON DEVELOPING CAMPAIGN EVALUATION METHODS TO MEASURE REDUCTION OF RAT DAMAGE TO AMAN RICE

A statistically valid method to measure the effectiveness of the rat control campaign in reducing rat damage to aman rice is needed. The VPS/BARI should develop these methods in cooperation with the DAE/MOA.

During the course of the campaign, research should be carried out in farmers' fields on the methods farmers use, how they use them, why they do control, and how effective the control was at reducing rat damage to aman rice. Data should be easily collected and entered into a computer for summary and analysis.

Suggested Method

Field work should be done in five districts growing aman rice: (1) Pabna or Natore, (2) Jessore, (3) Jamalpur or Sherpur, (4) Dhaka, and (5) Comilla or Noakhali are suggested.

In each district, one upazila is selected at random from the total, the only criterion is that aman rice should be present there. In the upazila, one group of 10 farmers who plan to do control and another 10 farmers who do not plan to do control are selected at random.

The fields of each farmer are surveyed for number of rat burrows and numbers of cut and uncut rice tillers before control (or no control) is done and again just before harvest. Farmers are interviewed about (1) the type of rat control done (poisoning, trapping, watering, digging), (2) the timing of control (time of month and crop growth stage), (3) how control was done (burrow baiting, surface baiting, trapping at burrow, etc.), and (4) why control was done (campaign, save crop, reduce rat numbers, neighbors did control, etc.). The group practicing control will be compared with the group not doing control (burrow counts, cut vs. uncut tillers, before campaign and at harvest) by ANOVA.

This should result in a sample of 100 farmers, 50 having practiced control and 50 who used no control. Their fields should be surveyed twice during the campaign.

SUGGESTED SURVEY FORM, RAT CAMPAIGN EVALUATION

District______(1-5) Upazila__________(6-10) Date________________

Did control (11-Y/N)

Method used: poison 12 trap 13 water 14 digging 15

Control timing: time of month (9/--10/--)

Crop growth stage 16-18 (tillering, booting, milk stage)

Why did control:

campaign 19 save crop 20 neighbors did control 21

received training 22 to win prize 23 other 24

	Active rat burrows	Tillers		
		Cut	Uncut	Total
Total Means				

TRIP REPORT*

Improving Extension Efforts in Rodent Control in Bangladesh

June 16-July 15, 1992

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ITINERARY

Date	Location	Activity
Jun 16-17	Athens, Georgia, to Dhaka, Bangladesh	Traveled
Jun 18	Dhaka	Arrived Dhaka and met with Mr. Santosh K. Sarker, Department of Agricultural Extension (DAE)
Jun 19	Dhaka	Studied briefing papers during holiday
Jun 20	Dhaka/Joydebpur	Hartal--general strike; met with Dr. Ray Morton, Program Officer, Agricultural and Rural Development, Agency for International Development (AID/Dhaka); visited Dr. Md. Abdul Karim, Head, Division of Entomology, at the Bangladesh Agricultural Research Institute (BARI); and met with Mr. Sarker
Jun 21	Dhaka	Met with Dr. Morton; major hartal (strike) today with some violence downtown
Jun 22	Dhaka	Visited DAE
Jun 24	Dhaka/Joydebpur	Met with Mr. Md. Emdadul Haque, Senior Scientific Officer, Vertebrate Pest Section (VPS)/BARI, and Dr. Karim regarding purpose of my visit; got letter from Dr. Karim explaining my mission to the Extension Service and requesting space
Jun 25	Dhaka	Returned to DAE and delivered letter from Dr. Karim
Jun 26	Dhaka	Spent holiday reading and researching information for Extension materials
Jun 27	Joydebpur	At BARI

Itinerary (Continued)

Date	Location	Activity
Jun 28	Dhaka	At DAE
Jun 29	Joydebpur	At BARI
Jun 30-Jul 2	Dhaka	At DAE and worked on posters
Jul 3	Dhaka	Spent holiday working on notes and report
Jul 4	Dhaka	At DAE
Jul 5	Dhaka area	At DAE and made brief field trip west of Dhaka to take footage for videotape
Jul 6	Tangal area	Traveled to rice growing area near Tangal
Jul 7	Dhaka	Visited the United Nations Food and Agricultural Office (FAO) and DAE
Jul 8		
Jul 9	Dhaka	Met with Mr. Abdul Malek, new Director of Plant Protection, at DAE; also visited Mr. Sarker at BARI
Jul 10		Spent holiday drawing and writing
Jul 11	Dhaka	Visited Parliament Building with Dr. Manjur Chowdhury to see vertebrate pest problems; also visited DAE
Jul 12	Dhaka/Joydebpur	Visited U.S. Embassy, DAE, and BARI
Jul 13	Dhaka	At DAE
Jul 14	Dhaka/Joydebpur, Bangladesh, to London, England	Attended summary meetings with staff at DAE and BARI; traveled
Jul 15-20	London	Spent 5 days off duty
Jul 20-21	London, England, to Athens, Georgia	Traveled

OBJECTIVES

Purpose of Mission: To strengthen Extension efforts in rodent control in "aman" (monsoon) season rice production.

Assignments

1. Help prepare a training manual and audio visual materials for Extension workers and farmers.

2. Review and evaluate 1991 Extension efforts of rodent control campaign.

3. Evaluate use and effectiveness of mass media and other media.

4. Review and make recommendations on the training needs of Upazila (Thana) subject matter officers. "Upazila" was officially changed to "Thana" in July 1992. (Upazila is a subdistrict.)

5. Design a more effective rodent control campaign evaluation scheme.

SUMMARY

The Denver Wildlife Research Center has provided technical assistance in rodent control to Bangladesh for several years. This assistance has produced, among other things, a number of research papers which contain considerable useful information on rodent control in Bangladesh agriculture. The purpose of this mission was to examine how this information is used by the Department of Agricultural Extension (DAE) in Bangladesh and to make suggestions for improving use of rodent control material. Subsequently, this should help with the ultimate goal of providing more food for Bangladesh by reducing the considerable loss of rice to rodents.

This report follows the consultant's assignments listed above. Each numbered section applies to the corresponding number given under the objectives. A summary of progress made and/or suggestions for improvements are included in each section.

In general, my recommendations are as follows:

(a) Make more and better use of visual aids in the Extension program.

(b) Integrate many kinds of Extension media into an effective program.

(c) Develop a training program for Extension workers.

ACCOMPLISHMENTS

1. **Assignment**

Help prepare a training manual and audio visual materials for Extension workers and farmers. This was, in my opinion, my most important assignment; thus, I spent the most time on it.

Progress

My principal counterpart during this assignment was Mr. Santosh K. Sarker, Extension Specialist, DAE. I helped Mr. Sarker design illustrations which will be used for posters, mini-posters, lecture aids, a training manual, and farmers' leaflets. I also helped prepare text outlines to accompany the illustrations. See examples attached in Appendix A, which include:

(a) Rodent identification chart

(b) Keep rodents out of your house

(c) Best time of year to poison rats in aman season rice

(d) Digging is one way to find rats and kill them

(e) Likely places to find rat burrows during high water

(f) Natural enemies of rats--can you identify them?

(g) Rats live on high ground during floods; when water recedes, rats move to the fields

I took video footage showing rice culture, important pest rodents, locations for baiting, trap setting techniques, and other related topics. See Appendix B of video script. This video will be edited and prepared by the Denver Wildlife Research Center for instructional use in future control campaigns.

I reviewed farmers' leaflets previously developed by DAE. I worked with Mr. Sarker on improving the organization of these leaflets by integrating more "how to" information and using illustrations. See Appendix C showing second draft of 1992 leaflet. The second draft relies on instructional pictures, more "how to" information, and a pared-down text. Also, I made a collection of previous Extension materials (Appendix D).

2. Assignment

Review and evaluate Extension efforts of the 1991 rodent control campaign.

Review

Extension information on rodent control in the aman season rice is given out during a campaign in September and October. The farmers' leaflet was the only piece of literature for farmer use (Appendix C). In the past it has been prepared new each year. It has been all text with no pictures.

Extension information on rodent control flows through the hierarchy diagramed below:

Central Headquarters, DAE, Dhaka
↓
District Deputy Director of Agricultural Extension (DDAE)
↓
Upazila - Upazila Agriculture Officer
↓
Block Supervisors and Dealers
↓
Contact Farmers
↓
Noncontact Farmers and Villagers

Mass media are also used. The primary purpose of mass media is to bypass the above hierarchy and reach farmers directly.

Evaluation

I was not in Bangladesh for the campaign, so evaluating it was the most difficult part of my assignment. Mr. Sarker has a good understanding of how and when rodent control should be done. The difficulty is in reaching and teaching the target audience.

Reportedly, the weakest link lies between contact farmers and the noncontact farmers/villagers in the information flow hierarchy. Examination by Extension professionals of the information transfer process in the field might lead to improving this deficiency.

Although mass media were used to bypass the hierarchy and reach the farmers directly, mass media usually cannot be used to teach detailed techniques. Mass media can, however, motivate farmers to seek out Extension workers and obtain specialized information.

Printed media should teach using graphics and a minimum of text.

In general, the effectiveness of Extension rodent control information can be improved by increasing the use of illustrations in the printed media, and increased use of mass media.

3. **Assignment**

Evaluate use and effectiveness of mass media and other media.

True mass communication reaches general audiences. Examples are radio, television, and general newspapers. Mass media are usually unsuitable for detailed "how to" technical information. Mass media are basically free advertising for the Extension service. They can be used to direct potential clientele to Extension workers who can then provide them with detailed information.

If I understand the Extension system correctly in Bangladesh, contact farmers come in between Extension workers and the majority of the farmers. If Extension truly intends to work "top down"--with contact farmers who are already known to Extension--then mass media are probably of little value in getting noncontact farmers to seek out Extension workers. On the other hand, if the DAE wishes to be guided by a farmer's ambition and demand for information, then mass media can find clientele and motivate them to seek out their Extension agents.

Time and space in mass media are expensive. Stories and space are used to sell advertising. Therefore, there is usually a high demand for space in mass media. One way for public service information to successfully compete for time and space is to put the information into story form. As an example, I wrote a story for American newspapers about the problem of rats in rice in Bangladesh. This story was distributed through the Georgia Cooperative Extension Service to hundreds of media outlets, some of which used the story. Such stories can often end with, "For more information, see your Extension agent." However, note recommendation on page 8, item 4, on not advertising the availability of agents unless they are prepared to help.

Comics

I saw an awareness level comic on rodent control that was intended to be delivered to children via the school system. This is not mass media, as it has to be printed at the expense of the Extension service. Rather, it is targeted information aimed at children and dependent on intermediaries in the school system who may have little motivation to distribute it. Mass media, on the other hand, are produced and distributed by free enterprise agencies to make a profit. If the value of a comic is not clearly demonstrated, then the money would probably be better spent on targeted training materials.

Posters

The posters I saw are among the best of the Extension materials in Bangladesh. Some of them help clearly visualize the rodent control problem and convey information about rodents and rodent control. A complete set of posters can serve multiple duty as free standing posters, as lecture aids for Extension workers, and they can be reduced in size to serve as illustrations in training manuals or as mini-posters or handbills.

Recommendations

Following is a summary of media and their potential uses for delivering information to Extension workers and their audiences.

Try to have the audience hear the message three times. A single message usually does not work.

Posters, like comics, have the disadvantage that they must be produced by the Extension Service. However, their distribution is relatively easy to control. They are very appropriate for teaching and giving visibility to the organization.

Medium	Uses
General newspapers	General public awareness.
Targeted newsletters for Extension workers, farmers	Good for awareness and short technical articles. A training aid.
Posters	Awareness and "how to" information.
Comics	Awareness level information for school children. There may be no incentive for distribution within the school system.
Posters	Give visibility to Extension programs. Also good for simple "how to" technical information.
Mini-posters/handbills	Cheap and useful, use indoors or outdoors, or as handouts.
Training manual	Should be prepared in brief outline form to serve as foundation for lectures which expand on the outline. Use lots of pictures.
Farmer's leaflet	Should incorporate best features of posters. Feature "how to" information. Keep explanations to reasonable minimum.
Radio	For advertising Extension programs and to deliver information on where to get more information.
Commercial television	As for radio.
Custom-made video tapes	Should feature "how to" and technical information insofar as possible. Suitable for training farm workers whenever audience can be assembled. Novelty makes videos attractive in rural areas. A drawback is that videotapes are expensive to produce. This is offset by the fact that they are inexpensive to copy and show where television and VCR facilities are available.

4. <u>Assignment</u>

Review and make recommendations on the training needs of Thana (Upazila) subject matter officers.

I had no discussions with Thana officers. However, based on observations of Extension materials and general information from my Extension counterpart, Thana officers need simple Extension leaflets featuring pictures and simple text to give to farmers. They also need improved training aids including posters to illustrate lectures. Videotapes can attract audiences in the countryside where videotapes are a novelty. Extension workers would, by all accounts, benefit from regularly scheduled training courses--not just in rodent control, but the more general area of vertebrate pest management.

<u>The Extension Service should not promote availability of its agents unless they are trained, ready, and willing to aggressively follow up on requests.</u> <u>Otherwise, the reputation of the organization will suffer</u>. Agents feel blind-sided and morale suffers if clientele ask for information which the DAE has not prepared them to deliver.

5. <u>Assignment</u>

Design a more effective rodent control campaign evaluation scheme.

Although this assignment asks for a year's worth of Extension work and I was only in Bangladesh a month, I do have a few suggestions on improving the campaign evaluation.

This year, researchers at the Vertebrate Pest Section (VPS) of the Bangladesh Agricultural Research Institute (BARI) evaluated the rodent control campaign. I did not see the completed report, as it was still in preparation. My comments are based on reading previous reports of Saltz, Fiedler, and Brooks, pertaining to the evaluation as well as conversations with Dr. Karim and others at BARI. I also read the English translation of this year's farmer interviews provided by Mr. Rajat Pandit.

The evaluation had two aspects (Brooks, 1992):

(a) Inspection of rice fields for rat burrows and rat damage, i.e., rodent census

(b) Farmer interviews aimed at discovering what farmers do to control rodents and where they get their information

I have little to suggest on the improving <u>rodent census</u> methods, beyond what Lynwood Fiedler proposed in his 1991 report. A review of the Breeding Bird Census done by the U.S. Fish and Wildlife Service might provide ideas. The U.S. Forest Service survey of timber inventories is also a good source of methodology. Both of these surveys periodically revisit locations and note changes. A problem with surveying rodents in rice is their clumped distribution.

Farmer interviews probably did not provide valid information (Appendix E); however, if reformatted or had different methods of asking questions been used, the information might have been valid. Past evaluations suggest that information delivery to farmers is working extremely well and farmers are doing a lot of rodent control. For example, in 1991, 94 percent of all farmers practiced some form of control according to Saltz (1991). Eighty-four percent of noncontact farmers did rat control in the 1990's; this increased to 90 percent in 1991 (Saltz, 1991). Fiedler (1991) reported that training reached more than 90 percent of contact farmers and 50 percent of other farmers.

These results would be outstanding even in a developed country. I suspect that many of farmers' answers are the result of the interviewer leading the respondent. Given a choice of "yes" or "no," people have the option of providing the answer they think the interviewer wants. This is a common result with questionnaires that have "yes/no" answers. The reason for "yes/no" questionnaires is that they generate data suitable for scientific research and statistical tests. However, such a line of questioning is likely to give misleading results. Interviewers should use intuition and common sense to get another view. For example, they could begin farmer interviews by hiding the note pad and pencil and other signs of bureaucracy. Very informally, without revealing that an interview is about to take place, the interviewer can engage the farmer in small talk and then ask something like, "What's the best way to get rid of rats around here?"

If the farmer responds by mentioning the correct method of baiting and the correct time of year, then the interviewer knows information delivery is working. The interviewer can follow up with a questions such as, "Is it worthwhile killing them? Do you bother with any field rodent control?" This gives more accurate information on how much rodent control the farmer has done.

Out of sight of the farmer, the interviewer can record the answers. I predict that open-ended questions like these will give a very different picture of how well rodent control information is being implemented at the farmer level. If scientific research on the details of farmers' knowledge and where they get it is desirable, a series of followup questions can be posed.

Other Comments and Suggestions

Rat Tail Contest

In the past, the Extension service has conducted a rat tail contest in which farmers compete to gather the most rat tails for a prize. While bounties are of doubtful value as a control technique, prizes do serve to give visibility to the rodent control problem. It is my opinion that to limit costs of the program, bounties on a "per tail" basis should be avoided. Limiting prizes is another way to limit the costs of the program.

Mini-Posters and Handbills

Mini-posters and handbills can present simple "how to" information. They can be as small as 7 x 10 cm. Many mini-posters could be put up outdoors on trees or buildings, or handed out. These have value as a way to repeat an Extension message very cheaply.

Main Rodent Control Messages

Repeat these messages over and over. Don't embellish them with long text and other messages. Focus on simplicity. For example, a poster could be made that illustrates the farmer should:

(a) Put one, 5-g wax block bait into one burrow in each burrow system.

(b) Do this in September before the booting stage.

Distribution of Rodent Control Information to Other Outlets

Many nongovernmental organizations are involved in providing rodent control information. They need to be supplied with Extension information.

CONTACTS AND ACKNOWLEDGMENTS

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Tel. 253030, 282397
(Sells Rodenticides)

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Rodent Identification Chart

EXAMPLE -- POINTS FOR SPEAKER TO MAKE WHEN USING VISUAL "IMPORTANT RODENT PESTS OF RICE."

Bangladesh has many kinds of rodents. These five are destructive. Most have a gestation period of about 3 weeks. They bear several young at a time. They raise several families a year. Learn to identify them.

Habits:

House Mouse -- Likes to live in houses, will burrow. Burrow opening about 2.5 cm in diameter.

House Rat -- Likes to live in houses. Usually does not burrow. Climbs well.

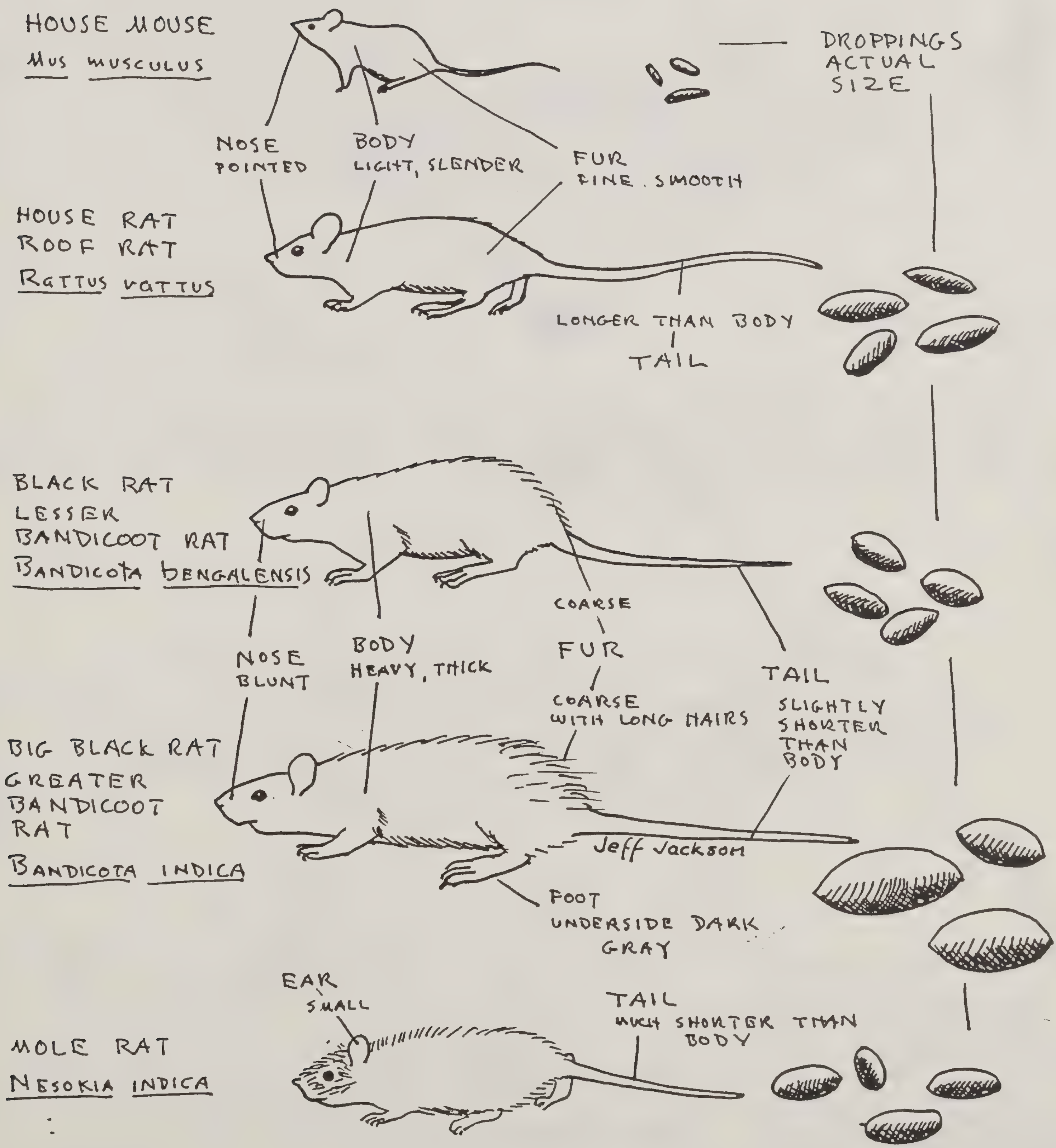
Mole Rat -- Seldom seen -- lives in extensive burrow system. Damages dikes.

Black Rat -- Lives in fields or houses. Burrows about 6 - 8 cm in diameter. Stores much grain in burrow.

Big Black Rat -- Lives in fields. Burrows about 8 - 10 cm in diameter.

Important Rodent Pests of Rice

Bangladesh



Keep rodents out of your house

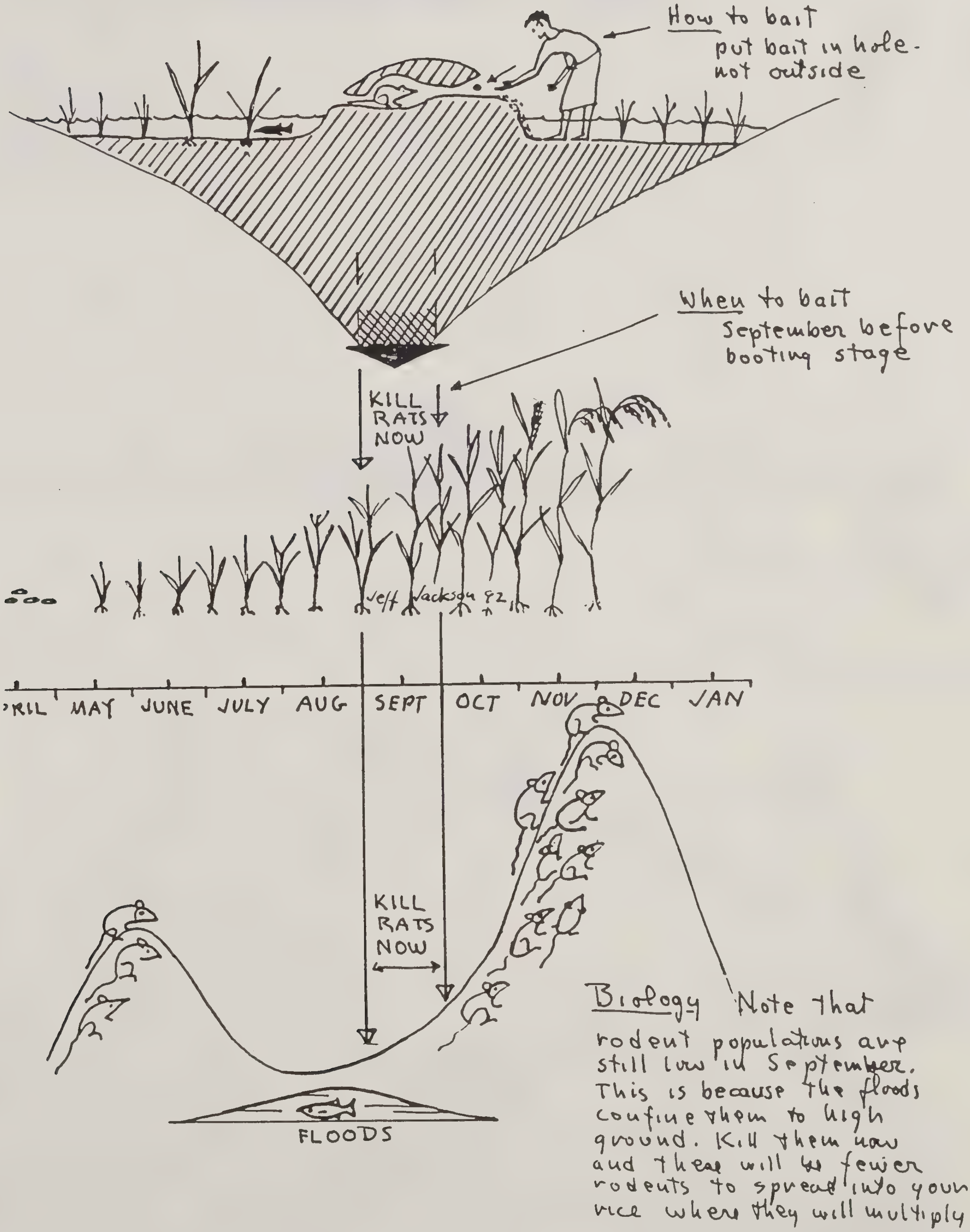
Why?

They are unclean

They eat your food

They spread disease

Best Time of Year to Poison Rats in Aman Season Rice



Digging is One Way to Find Rats and Kill Them

Likely Places To Find Rat Burrows

During High Water

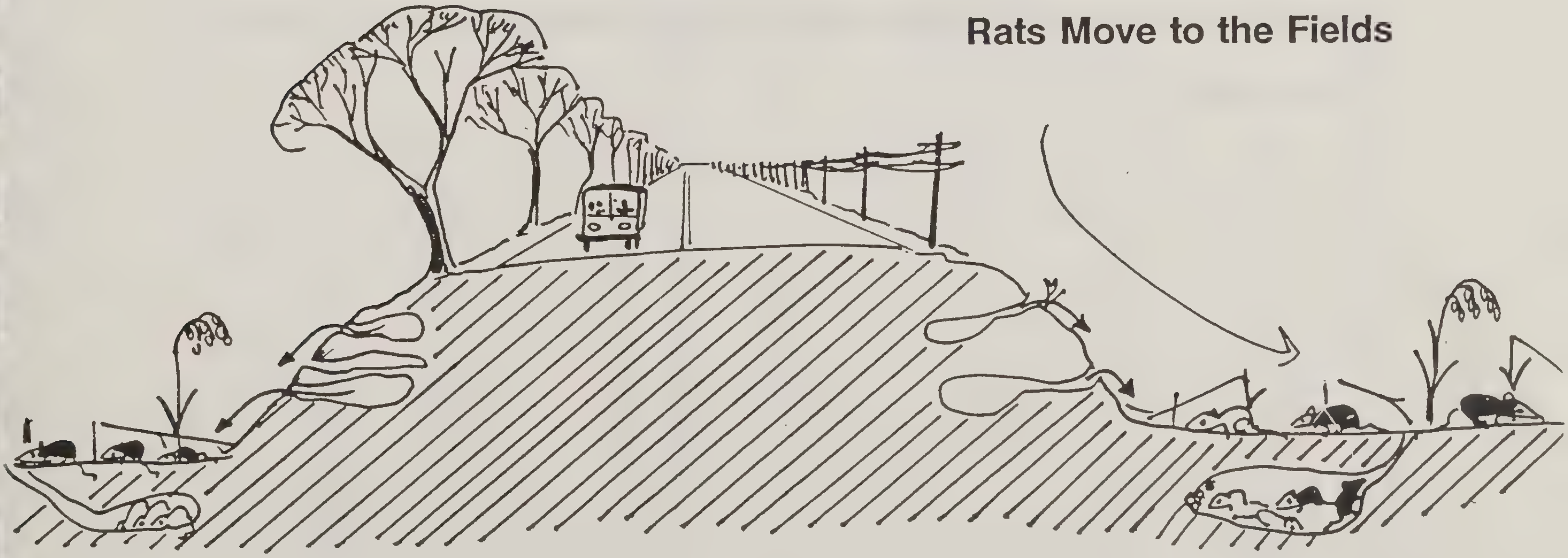
Road Banks
Dikes
River Banks
Pond Banks
Railroad Banks
Houses

Natural Enemies of Rats--Can You Identify Them?

Rats Live on High Ground During Floods

When Water Receeds,

Rats Move to the Fields



Rats Live on High Ground During Floods

Control rats when water is high.

When water is high, rats are relatively less common. They are concentrated on high ground where they are easy to find.

If you delay rodent control until after water recedes, rats will spread into rice fields. There they will multiply and destroy much rice.

September, before the booting stage, is a good time to kill rats in aman season rice.

Draft Outline - Video

Points to Make	Footage
Value of rice to Bangladesh. Rice is the staple food--the staff of life.	Rice Field
It takes lots of time and work to raise a crop-- Seeding, plowing, leveling, transplanting, and weeding.	Stages of rice production
You and your children depend on rice	Children
Unfortunately, rats take a percentage of the crop (perhaps 3-5 percent nationwide). Uncontrolled rodents may take far more. Rat damage rice in the early stages by cutting the stem. Later, they eat the grain as well. They may store large amounts of rice underground.	
Bangladesh has dozens of kinds of rodents, but these are the main pests.	Footage of individual species
These rodents burrow under the soil. They normally come out to feed at night.	Diagram

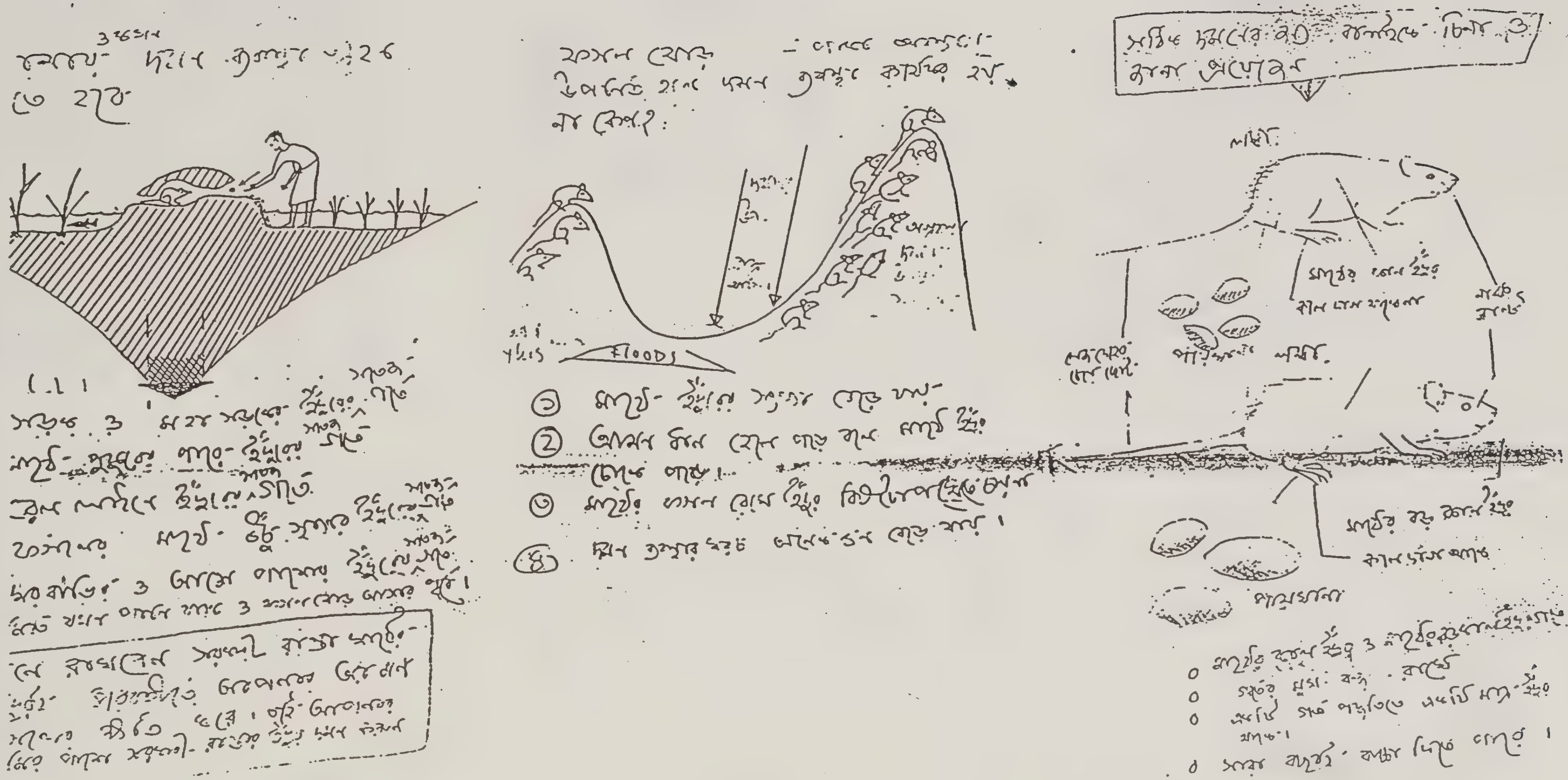
During the dry season, rodents can burrow almost anywhere. During the floods, they must move to high ground in dikes, ditchbanks roadsides, along railroad lines.	Flooded rice fields. Embankments in background-foreground
This is the best time to kill them--when they are concentrated in limited living space.	
Scientists with the Denver Wildlife Research Center; USAID, and the Bangladesh Agricultural Research Institute have developed effective control measures for these rats.	
The easiest way is poison bait. Kill them this way. Find a burrow system. There will be several entrances. Open one of these as shown here.	Opening burrow
Place the bait directly in the burrow. Push the bait in with a stick.	How to place bait in burrow
Usually only one rat lives in a burrow system. A single 5-gram wax bait block is enough to kill the rat.	
The best time to poison rats is just before booting stage.	

This rice is in the booting stage. After the rice begins to develop, rat damage increases. Once the fields begin to drain, rats enter them--and with abundant food, they increase rapidly. Don't wait for this to happen. Apply bait early--before rice reaches the booting stage.	Rice in booting stage.
Encourage your friends to kill rats at this time--so their rats --and their rat's offspring--cannot come to your field.	
If rats live on public property, such as road and railroad rights-of-way, it may pay to kill these too, even though it is not on your own land.	
Rats in houses are dirty. Not only do they eat food, they contaminate it with their hair, urine and droppings.	Diagram of rat and droppings Santosh showing traps.
Use traps in and around home. There are many kinds of traps. Set them along walls, near haystacks, or other likely places.	House, haystack.
There are many kinds of traps.	Types of traps.

This is how to set a snap trap.	How to set a snap trap.
Rats like to run along walls. Don't set trap parallel to wall or away from wall. Set trap perpendicular to wall like this. Bait the treadle. Put a little free bait on each side to help the rat overcome his fear of the trap. Brace with a brick or heavy object to help the trap deliver a strong blow to the rat.	
If you control rats, you will have more rice for you and your children	Rice scenes--children

Credits

Second Draft 1992 Farmer's Leaflet - After Input from Extension Consultant



Appendix C

আমন ফসলে ইঁদুর দমনের সবচেয়ে উপযুক্ত সময়: ভাদ্র – ১৫ই কার্তিক

কারণ

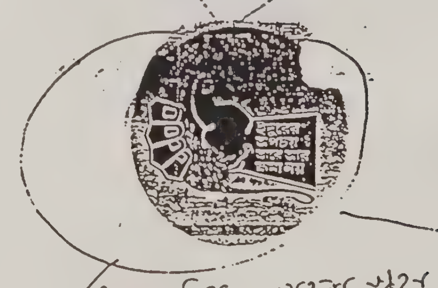
১ মাঠে ইঁদুরের সংখ্যা কম থাকে।
২ জমিতে পানি থাকে বলে ইঁদুর
আশ্রয়: উঁচু স্থানে, রেল লাইনে, সড়ক ও মহাসড়কে, বাঁধে [illegible] পুকুরের পাড়ে, খালের [illegible] কচুরি পানায় [illegible] অবস্থান নেয়।
৩ মাঠে প্রচুর খাদ্য না থাকায় সহজেই বিষটোপ ইঁদুর খেয়ে নেয়।
৪ এসময় [illegible] ইঁদুর মারলে [illegible] সংখ্যা বৃদ্ধি হতে পারবে না [illegible] ক্ষতিও কম হবে [illegible]।

বিষটোপ কোথায় প্রয়োগ করতে হবে

১ বিষটোপ সক্রিয় গর্তে প্রয়োগ করতে হবে
২ [illegible] গর্ত [illegible] [illegible] মুখ [illegible] [illegible] মাটি [illegible]
৩ [illegible] গর্ত [illegible] [illegible]
৪ [illegible]

আসুন সবাই ইঁদুর মেরে দেশ সমৃদ্ধ করি।

[illegible]



[illegible] ইঁদুর দমন করি [illegible]

[illegible]
কৃষি সম্প্রসারণ অধিদপ্তর
খামারবাড়ি, ঢাকা [illegible]

Previous Department of Agricultural Extension Material

Used in Rodent Control

আসুন সবাই মিলে ইঁদুর মেরে দেশের সম্পদ রক্ষা করি

FIRST DRAFT - 1992 FARMERS LEAFLET - PRIOR TO INPUT FROM EXTENSION CONSULTANT

ইঁদুর খাদ্যের বড় চোর
পরিবেশের দূষণকারী, পানি ও খাদ্যে বিষ
ক্রিয়া এবং সেচের পানির অপচয়
ঘটায়

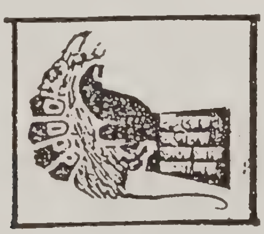
গর্ত খুঁড়ে দালান কোঠা, ঘরবাড়ি,
সড়ক, মহাসড়ক, রেল লাইন,
বাঁধের ভিত দুর্বল করে ফেলে।

আসবাব পত্র, বই পুস্তক, লেপতোষক,
দলিল পত্র কেটে কুটে নষ্ট করে।

ইঁদুর তার দেহের ওজনের ১০ ভাগ
খাদ্য দৈনিক খায় এবং ৭/৮ গুণ
কেটে কুটে গর্তে ভরে নষ্ট করে।

ইঁদুর দ্রুত স্থান পরিবর্তন করে, বাচ্চা
প্রদানের ৪৮ ঘন্টার মধ্যে গর্ভধারণ
করতে পারে, প্রতি ২১/২২ দিন পর
পর ১০-১৫ টি করে বাচ্চা দেয়।

মলমূত্রের মাধ্যমে মারাত্মক রোগের
বিস্তার ঘটায় এবং মানুষের
প্যারাসাইটের অন্যতম বাহক।



ইঁদুর মারা সপ্তাহের কাজ
গ্রামবাসীরা বর্ষার সময় অন্তত একদিন
ঘরবাড়ি, মাঠের রাস্তাঘাট এবং
উঁচু স্থান এবং কচুরীপানার ইঁদুর
মারলে আমন ফসলের ক্ষতি
অনেকাংশে ঠেকাতে পারে।
~~করতে পারে না~~

ইঁদুর খুব চালাক প্রাণী, খাদ্যের বিষাক্ত
দ্রব্য সনাক্ত করতে পারে তাই একটি
দমন ব্যবস্থা কার্যকর ~~নহে।~~ নয়।

ইঁদুরের সংখ্যা যখন কম থাকে, এবং
ফসল থোড় আসার পূর্বেই দমন
ব্যবস্থা অধিক কার্যকর হয়, কম পরিশ্রম
ও ~~এবং~~ কম খরচ ~~কম হয়।~~ ও কম লাগে।

বর্ষার সময় ধানের জমির পাশে
কচুরী পানার দল অথবা
আবর্জনার স্তূপের ইঁদুর টেটা অথবা
ফাঁদ অথবা বিষটোপ প্রয়োগ করে
মারা যায়।

লাঠি, বাঁশ, মাটির ফাঁদ পেতে,
গর্ত খুঁড়ে, পানি ঢেলে, ক্লেরাট/
লেনিরাট/জিংক ফসফাইড
বিষটোপ/গ্যাসবড়ি দিয়ে
ইঁদুর দমন করা যায়।

আমন মওসুমে ইঁদুর দমন অভিযান'৯২ এ অংশ গ্রহণ করুন ও ~~সোনালী~~
জাতীয় পর্যায়ের পুরস্কার পাওয়ার সুযোগ গ্রহণ করুন।

নিকটস্থ
বিস্তারিত জানার জন্য কৃষি কর্মীর সাথে যোগাযোগ করুন।

আসুন সবাই মিলে ইঁদুর মারি

ইঁদুর মানুষের খাবারে ভাগ বসায়।

মাঠের ফসল, বাগান, ঘরবাড়ি, গুদাম, কল-কারখানা সবত্রই ইঁদুর বিপুল ক্ষতিসাধন করে থাকে।

সড়ক, মহাসড়ক, রেল লাইন ও বাঁধে ইঁদুর কর্তৃক গর্ত করার ফলে বর্ষার পানিতে সেগুলো সহজে ভেংগে যায়। ফলে, কোটি কোটি টাকার ক্ষতি হয়।

ইঁদুর পানি ও খাদ্যে বিষক্রিয়া, প্লেগ, কলেরা, আমাশয়, টাইফয়েডসহ প্রায় ৩৫ প্রকারের মারাত্মক রোগের বিস্তার ঘটায়।

বৈদ্যুতিক তার কেটে অগ্নিকান্ড ঘটায়, কিংবা বিদ্যুৎ প্রবাহ বন্ধ করে দেয়।

আমন ধানে ক্ষতির পরিমাণ সবচে' বেশী; প্রতি বছর সাড়ে চার কোটি মেট্রিক টন আমন ধান ইঁদুরের পেটে যায়।

একটি ইঁদুরের উপস্থিতি দেখা মাত্র যে কোন উপায়ে তা মেরে ফেলুন। দেরী করলে ইঁদুরের সংখ্যা ও ক্ষতি বেড়ে যাবে।

গ্রামবাসীগণ সবাই মিলে একই সময়ে রাস্তাঘাটসহ আমন ফসলের ক্ষেতের সকল ইঁদুর মেরে ফেলুন।

আমন ধানে থোড় আসার পূর্বেই মাঠের ইঁদুর মেরে ফেলতে হবে। কারণ ধানে থোড় ও পাকা অবস্থায় দমন ব্যবস্থা তেমন কার্যকর হয় না।

গুরুত্ব সহকারে মহাসড়ক, রেল লাইন, বাঁধ, পতিত উঁচু জায়গা ও সেচের নালার ইঁদুর মারুন। এ সকল ইঁদুর ফসলের ক্ষেতে ঢুকে ক্ষতি সাধন করে।

একটি দমন ব্যবস্থার ওপর নির্ভর না করে একই সংগে একাধিক দমন ব্যবস্থা গ্রহণ করুন। ফাঁদ পেতে, গর্ত খুঁড়ে, পানি ঢেলে, বিড়াল পুষে, কিংবা বিষটোপ ব্যবহার করে।

ক'টি ইঁদুর মারা হয়েছে সেটা না দেখে ক'টি ইঁদুর বেঁচে রয়েছে, সেটিই আপনাকে বিবেচনা করতে হবে।

মনে রাখবেন, একবার ইঁদুর মারলে হবে না, দমন ব্যবস্থা বন্ধ করলে ইঁদুরের সংখ্যা বেড়ে যায়। তাই, সব সময় ইঁদুরের প্রতি সজাগ দৃষ্টি রাখুন।

আমন মৌসুমে ইঁদুর দমন অভিযান '৯১—এ অংশগ্রহণ করুন। নিজে ইঁদুর মারুন, প্রতিবেশীকে ইঁদুর মারতে উৎসাহিত করুন। সে সংগে জাতীয় পর্যায়ের পুরস্কার পাওয়ার সুযোগ গ্রহণ করুন।

বিস্তারিত জানার জন্য কৃষি কর্মীর সাথে যোগাযোগ করুন।

Rainy Season - 1990 - farmers leaflet 100,000 - 200,000 printed

Kill rats - save national wealth

আসুন সবাই মিলে ইঁদুর মেরে দেশের সম্পদ রক্ষা করি

- ঘরবাড়ির ইঁদুর দমনের উপযুক্ত সময় আগস্ট মাস।
- সম্মিলিতভাবে আগস্ট মাসে ঘরবাড়িতে ইঁদুর দমন করা হলে পরবর্তীতে আমন ফসলে ইঁদুরের আক্রমণ কম হয়ে থাকে।
- গ্রামের প্রতিটি বাড়ির প্রতিটি স্থানে একই সময়ে দমন ব্যবস্থা গ্রহণ করলে খরচ কম এবং দমন ব্যবস্থা অধিক কার্যকর ও দীর্ঘস্থায়ী হয়ে থাকে।
- জিংকফসফাইড, ব্রোডিফেকাম, রেকুমিন, লেনীর‍্যাট ব্যবহার করে ঘরবাড়ির ইঁদুর দমন করা যায়।
- রেকুমিন ও লেনীর‍্যাট বহুমাত্রা ওষুধ। যতদিন ইঁদুরের বিষটোপ খাওয়া বন্ধ না করে ততদিন বিষটোপ পাত্রে রাখতে হবে।
- বিভিন্ন প্রকার ফাঁদ যেমন—বাঁশ, কাঠ, লোহা এবং মাটির তৈরী ফাঁদ দিয়েও ইঁদুর দমন করা যায়।
- জিংকফসফাইডের সঠিক মাত্রার তৈরি বিষটোপ না হলে ইঁদুর খাবে না, আবার খেলেও মারা যাবে না। তাই অনুমোদিত লেবেল দেখে জিংকফসফাইডের তৈরি বিষটোপ ক্রয় করে ব্যবহার করতে হবে।
- আমন ফসলের ইঁদুর দমনের উপযুক্ত সময় সেপ্টেম্বর-অক্টোবর মাস।
- সম্মিলিতভাবে সেপ্টেম্বর-অক্টোবর মাসে আমন ফসলে ইঁদুর দমন ব্যবস্থা গ্রহণ করা হলে রবি ফসলে ইঁদুরের আক্রমণ কম হবে।
- ফসলের মাঠের উঁচু আইল, জায়গা, সরকারী ও বেসরকারী রাস্তা, রেল লাইনের ধারের ইঁদুর একই সময়ে নিধন করলে আমন ফসলের ক্ষতির সম্ভাবনা কমে যাবে।
- গ্যাস বড়ি, ব্রোডিফেকাম এবং জিংকফসফাইড দিয়ে মাঠের ইঁদুর সহজে দমন করা যায়।
- জিংকফসফাইড এবং ব্রোডিফেকাম একবার খেলেই ইঁদুর মারা যায়।
- নূতন গর্তে একটি গ্যাস বড়ি ব্যবহার করতে হবে এবং সংলগ্ন অন্যান্য গর্তের মুখ মাটি দিয়ে ভালভাবে বন্ধ করে দিতে হবে।
- ব্রোডিফেকামের ৫ গ্রামের একটি ব্লক এবং জিংকফসফাইডের একটি টুকরা নূতন গর্তে প্রয়োগ করতে হবে।

ইঁদুর দমনের কলাকৌশল বিষয়ে বিস্তারিত জানতে হলে নিকটস্থ ব্লক সুপারভাইজার অথবা উপজেলা কৃষি অফিসে যোগাযোগ করুন।

প্রকাশনায়ঃ কৃষি-সম্প্রসারণ অধিদপ্তর, খামারবাড়ি, ঢাকা-১২১৫।

কৃতসা অঃ মুঃ—৪২৩, তাং—৩/৬/৯০ ইং, ২,০০,০০০ কপি।

1990 Rabi season - winter - for farmers - ~~paddy~~, wheat
BANGLADESH

আসুন সবাই মিলে ইঁদুর মেরে রবি ফসল রক্ষা করি

Kill together rats to save crops

সম্মিলিতভাবে একই সময়ে খেসারী, সরিষা, গোল আলু, বোরো ধানের বীজ তলায়, সেচের উঁচু আইলে, ঘরবাড়িতে ইঁদুর দমন ব্যবস্থা গ্রহণ করা উত্তম।

বোরোর জমিতে পানি থাকে বলে ইঁদুর আইলে বাস করে এবং ধানের ক্ষতি সাধন করে থাকে।

ফসলের জমিতে মাঠের কাল ইঁদুর এবং মাঠের বড় কাল ইঁদুর বেশী ক্ষতি করে থাকে।

ঘরবাড়িতে, গুদামে মাঠের কাল ইঁদুর, গেছো ইঁদুর এবং সোলাই বা বাত্তি ইঁদুর ক্ষতি করে থাকে।

ঘরবাড়িতে, গুদামে ফাঁদ পেতেও ইঁদুর দমন করা যায়।
বোরো ক্ষেতের বীজ তলার ইঁদুরের গর্তে পানি ঢেলে সহজেই দমন করা যায়।

গম ফসলে ইঁদুর দমনের সবচেয়ে উপযুক্ত সময় মাঘ মাস।

ক্ষেতের আইল চিকন রাখলে ইঁদুরের উপদ্রব কম হয়ে থাকে।

থোড় অবস্থায় উপনীত হওয়ার পূর্বেই বিষ টোপ দিয়ে ইঁদুর মারার ব্যবস্থা গ্রহণ করতে হবে।

সতেজ গর্তের ভিতরে বিষটোপ প্রয়োগ করতে হবে। চলাচলের রাস্তায় বা মুখে বিষটোপ ব্যবহার করলে কম কার্যকর হয়ে থাকে।

অল্প মাত্রার তৈরী বিষটোপ খেলে ইঁদুর মরে না। অধিক মাত্রার তৈরী বিষটোপ ইঁদুর খায় না। সঠিক মাত্রার বিষটোপ ব্যবহার করতে হবে।

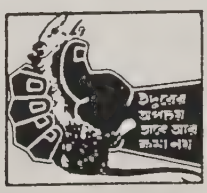
অনুমোদিত লেবেল দেখে কীটনাশক ডিলারের দোকান থেকে তৈরী জিংকফস্‌ফাইড অথবা রেকুমিনের প্যাকেট ক্রয় করে ব্যবহার করুন।

বর্তমানে রবি মৌসুমে ইঁদুর দমন অভিযান ১৯৯০ চলছে। এ অভিযানে অংশগ্রহণ করে ও ইঁদুরের লেজ জমা দিয়ে আপনিও পুরস্কার পেতে পারেন।

পুরস্কারের নমুনা নিম্নরূপ ঃ

জেলা পর্যায়
কৃষক ঃ একটি এক ব্যাণ্ড রেডিও।
বুক সুপার ভাইজার ঃ একটি এক ব্যাণ্ড রেডিও।
একটি শিক্ষা প্রতিষ্ঠান ঃ একটি এক ব্যাণ্ড রেডিও।

ইঁদুরের লেজ জমা দেওয়ার সময় ঃ
১৫ই জানুয়ারী থেকে ১৫ই মার্চ, ১৯৯০



ইঁদুর দমনের বিষটোপ এবং প্রতিযোগিতার বিষয়ে বিস্তারিত জানতে হলে নিকটস্থ বুক সুপারভাইজার অথবা উপজেলা কৃষি অফিসে যোগাযোগ করুন।

প্রকাশনায় ঃ কৃষি সম্প্রসারণ অধিদপ্তর, খামারবাড়ি, ঢাকা-১২১৫।

সংখ্যা দুই মাঘ/১৯৯০

মুদ্রণে ঃ বাংলাদেশ প্রগ্রেসিভ এন্টারপ্রাইজ প্রেস লিঃ

BANGLADESH FARMER LEAFLET

Save wheat crops by killing rodents

ইঁদুর মেরে গম ফসল রক্ষা করুন

জানেন কি ?

—ডাল, তৈলবীজ ও সবজি জাতীয় অন্যান্য পার্শ্ববর্তী ফসলের ক্ষেতের ইঁদুর আপনার গম ফসলে এসে ক্ষতি করে থাকে।

—গম ফসলে মাঠের কাল ইঁদুরের আক্রমণ বেশী হয়ে থাকে।

—গম ফসলে ইঁদুর থোড়-পাকা অবস্থায় সবচেয়ে বেশী ক্ষতি করে থাকে।

—মধ্য পৌষ-মধ্য চৈত্র সময়ে গম ফসলের ইঁদুর দমনের উপযুক্ত সময়।

—ইঁদুরের ক্ষতি থেকে গম ফসল রক্ষা করার দায়িত্ব জমির মালিকের, সরকারের নয়।

—ইঁদুর নিধনের জন্য সরকার থেকে কোন তৈরি বিষটোপ এবং ফাঁদ সরবরাহ করা হয় না।

—প্রত্যেক কীটনাশক ডিলারের দোকানে জিংক ফসফাইড ও রেকুমিন-এর তৈরি বিষটোপ পাওয়া যায়।

—ইঁদুরের তাজা অথবা নতুন গর্তের ভিতরে বিষটোপ প্রয়োগ করতে হবে।

—গর্তের মুখ বন্ধ থাকলে গর্তের মুখের মাটি পরিষ্কার করে বিষটোপ প্রয়োগ করতে হবে।

—গম ফসল থোড় থেকে কর্তনের পূর্ব পর্যন্ত প্রত্যেক দিন গম ক্ষেতে ইঁদুরের উপস্থিতি হয়েছে কিনা তা পরীক্ষা করতে হবে।

—একটি ইঁদুরের সক্রিয় গর্ত দেখা মাত্র যে কোনভাবে মারার ব্যবস্থা করতে হবে।

—গম ফসলে ইঁদুর দমন অভিযান-১৯৮৯-তে অংশগ্রহণ করে আপনি আকর্ষণীয় পুরস্কার পেতে পারেন।

—ইঁদুরের লেজ জমা দেওয়ার সময় ১লা ফেব্রুয়ারী—৩১শে মার্চ, ১৯৮৯ পর্যন্ত।

গম ফসলে জাতীয় ইঁদুর দমন অভিযান ১৯৮৯-এর ইঁদুরের লেজ জমাদান প্রতিযোগিতার পুরস্কারের নমুনা ১৯৮৯

RAT TAIL COMPETITION

জেলা পর্যায়ে ঃ

কৃষক	ঃ	একটি এক ব্যাণ্ড রেডিও
ব্লক সুপারভাইজার	ঃ	একটি এক ব্যাণ্ড রেডিও
একটি শিক্ষা প্রতিষ্ঠান	ঃ	একটি এক ব্যাণ্ড রেডিও

বিস্তারিত তথ্যের জন্য নিকটস্থ কৃষি সম্প্রসারণ কর্মীর সাথে যোগাযোগ করুন।

প্রকাশনায় ঃ

কৃষি সম্প্রসারণ অধিদপ্তর

খামারবাড়ি, ঢাকা—১২১৫

BANGLADESH Farmer leaflet – 1989
Kill rats yourself

আপনার ইঁদুর আপনাকেই মারতে হবে

ইঁদুর মারা সওয়াবের কাজ

জানেন কি ?

Do you know

Fields

ফসল ও রাস্তা-ঘাটের ক্ষতিকারক ইঁদুর

- মাঠের কাল ইঁদুর
- মাঠের বড় কাল ইঁদুর
- নরম পশমযুক্ত ইঁদুর

- গর্তে থাকে এবং গর্তের মুখ বন্ধ রাখে
- একটি গর্তে একটি ইঁদুর থাকে।

Kinds of rodents

Houses & Stores

ঘরবাড়ী ও গুদামের ক্ষতিকারক ইঁদুর।

- গেছো ইঁদুর
- নেংটি বা সোলই ইঁদুর
- মাঠের কাল ইঁদুর

- গাছে, ঘরের সিলিংয়ে, ময়লাযুক্ত অন্ধকার স্থান ও গুদামে থাকে।
- একত্রে একাধিক ইঁদুর বাস করে।

আমন ফসলে ইঁদুর দমনের উপযুক্ত সময়
ভাদ্র – আশ্বিন
Best Time

ফাঁদ পেতে, পানি ঢেলে, গর্ত খুঁড়ে এবং ক্লেরাট, লেনীর‍্যাট রেকুমিন, জিংক ফসফাইড, গ্যাস বড়ি ব্যবহার করে ইঁদুর দমন করা যায়।

ঘরবাড়ী ও রাস্তা ঘাটে ইঁদুর দমনের উপযুক্ত সময়
আষাঢ় – শ্রাবণ
Best Time

রেল লাইন ও উঁচু রাস্তা-ঘাটে একযোগে দমন ব্যবস্থা গ্রহণ করা দরকার।
সকল ফসলের জমিতে ও একই সময় দমন ব্যবস্থা গ্রহণ করতে হবে।

একটি ইঁদুর এক বিঘা জমির আমন ফসলের ক্ষতির জন্য যথেষ্ট।

জমির আইল ছোট রাখলে ইঁদুরের উপদ্রব কমে যায়।

ঘরবাড়ী পরিষ্কার রাখলে ইঁদুরের উপদ্রব কমে যায়।

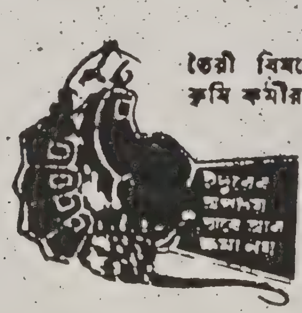
বিস্তারিত জানার জন্য কৃষি কর্মীর সাথে যোগাযোগ করুন।

1988 farmer leaflet - BANGLADESH

Best Time for Rodent Control in Aman Crops is Sept-Oct

আমন ফসলে ইঁদুর দমনের উপযুক্ত সময়
আশ্বিন-কার্তিক

- আমন ফসলের ক্ষেতে ইঁদুরের উপস্থিতি নির্ভর করে বর্ষার পানি সরে যাওয়ার উপর।
- বর্ষার পানি কমার সাথে সাথে ইঁদুর প্রথমে ক্ষেতের আইলে গর্ত করে থাকে।
- ক্ষেতের আইলে ইঁদুর দমন করা সহজ ও কার্যকর।
- বর্ষার সময় আপনার জমি, সরকারী উঁচু রাস্তা, বেড়ী বাঁধ ও রেল লাইনের অবস্থানরত ইঁদুর মেরে ফেলুন।
- মাঠের বড় কাল ইঁদুর ও মাঠের কাল ইঁদুর আমন ফসলের বেশী ক্ষতি করে থাকে।
- জিংক ফসফাইড ও র‍্যাকুমিনের তৈরী বিষ টোপ গর্তের ভিতর দিলে ভাল কাজ হয়।
- মনে রাখবেন আপনার আমন ফসল ধ্বংস করার জন্য একটি ইঁদুরই যথেষ্ট।
- গুইসাপ, অবিষধর সাপ, শিয়াল, বন বিড়াল, বেজী প্রতিদিন কম করে হলেও একটি ইঁদুর মারে। তাই এদের রক্ষা করুন।
- ফাঁদ পেতে, গর্ত খুঁড়ে ইঁদুর দমন করা যায়।
- ইঁদুরের লেজ জমাদান প্রতিযোগিতায় অংশ গ্রহণ করে আকর্ষণীয় পুরস্কার পেতে পারেন।
- ইঁদুর নিধন করা আর ইঁদুরভোজী প্রাণীদের রক্ষা করা আমাদের সকলের পবিত্র দায়িত্ব।
- কীটনাশক ডিলারের দোকানে ইঁদুর নিধনের ঔষধ পাওয়া যাবে।



তৈরী বিষটোপ এবং ইঁদুর দমন বিষয়ে পরামর্শের জন্য নিকটস্থ কৃষি কর্মীর সাথে যোগাযোগ করুন।

কৃষি সম্প্রসারণ অধিদপ্তর, খামারবাড়ি, ঢাকা-১২১৫

TRANSLATED FROM BENGALI
by
RAJAT PANDIT

SURVEY OF NATIONAL RAT CONTROL CAMPAIGN '91 IN AMAN RICE SEASON

QUESTIONNAIRE (FOR CONTACT/NON-CONTACT FARMER)

DISTRICT: UPA FILE: BLOCK:

NAME OF BLOCK SUPERVISOR: FARMER'S NAME:

VILLAGE: UNION:

1. Cultivable land area of different crops during Campaign '91:

Name of Crop	Land Area (Acre)
a)	
b)	
c)	

Total area of cultivable land (acre):

2. a. Did you heard about the Rat Control Campaign? Yes / No
   b. If yes, from whom?

3. a. Did you control rats in the last Aman season? Yes / No.
   b. If yes, where: (1) Aman Paddy Field (2) Dwelling Houses
   c. How? (1) Poison Bait (2) Trap (3) Digging Burrow
      (4) Watering in the Burrow (5) Other Means:

4. a. Did you control rats in Aman Field this year? Yes / No
   b. If yes, how many have you killed?
   c. Number of deposited rat tails?

5. Who helped you for rat control this time?

   (1) Block Supervisor (2) Contact Farmer (3) Neighborhood
   (4) Student (5) UP Member (6) Relative (7) Nobody

6. a. Received any training on rat control? Yes / No
   b. If yes, from whom?
   c. Received any of the following? Yes / No
      (1) Advice (2) Material Help/Commodities

(3) Encouragement (4) Financial Help

d. If yes, from whom?

7. Did you use any poison for rat control? Yes / No
   If yes: (a) Name of Poison: Source:

8. Which technique do you think good for rat control?

   Poison bait/Gas tablet/trap/Watering in the burrow/Other means

9. How was the damage in Aman crop this year compared to last year?

   Low __ High __ Same __

10. Do you think this rat control campaign successful? Yes / No
    Why successful/not successful?

11. What should be the approach for rat control campaign?
    individually/integratedly

12. Should the rat control campaign continue for the whole year?
    yes / No
    If yes, why?

13. Which month do you think appropriate for rat control in Aman crop?

Vadra (Mid August-mid-Sept.)	/Aswin (Mid Sept.-mid-October)	/Kartik (Mid-Oct.-mid Nov.)	/Ogrohhan (Mid Nov.-mid Dec.)

14. (a) In which month maximum rat damage occur in Aman crop?

    (b) Give the reason(s) for maximum rat damage.

15. What are the things do you think needed to make more successful rat control program?

    (1) Training (2) Good Rodenticide (3) Cash (4) Prize

Trip Report*

CHAD RODENT PROJECT

ADMINISTRATION, RESEARCH, AND TRAINING

August 9-September 13, 1992

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Unpublished Report

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ITINERARY

Date	Location	Activity
Aug 9-11	Denver, Colorado, via Paris, France, to N'Djamena, Chad, Africa	Travel
Aug 11-21	N'Djamena	Handled DWRC project administrative and fiscal details with the Agency for International Development (AID)/N'Djamena
Aug 22-24	N'Djamena to N'Gouri	Conducted field work
Aug 25-28	N'Djamena	Prepared for training workshop and conducted laboratory toxicity studies
Aug 29-30	Karal, Beltram	Managed field studies
Aug 31-Sep 12	N'Djamena	Prepared for and presented training workshop; conducted laboratory toxicity studies
Sep 13	N'Djamena, Chad, via Paris, France, to Denver, Colorado	Travel

INTRODUCTION AND OBJECTIVES

The Chad Rodent Control Research Project (RCRP) was initiated in October 1989 and field work on rodents of the Sahel was carried out until the departure of the resident Project Leader, Dr. J. Juan Spillett, in early December 1991. Since that time, no field work has been done. Dr. Maho Angaya, the Project Assistant who was hired in late November 1991, has carried out limited laboratory work and he has extensively translated into French all the Project documents as well as the training manual which I had drafted.

The objectives of this TDY were to: (1) prepare budgetary and administrative details in agreement with AID/N'Djamena and work plans for the balance of the Project until the Project Agreement Completion Date (PACD) on December 31, 1992, so that the Project might attempt to meet goals and objectives by December 31, 1992, (2) revisit the Project sites at N'Gouri and Karal to activate the field studies prior to Dr. Dolbeer's visit, (3) prepare and present a 5-day workshop in rodent research and control in N'Djamena to Private Voluntary Organizations (PVO's), Non-Governmental Organizations (NGO's), and Ministry of Agriculture personnel, and (4) carry out laboratory toxicity studies of rodenticides on multimammate rats (*Mastomys natalensis*) and unstriped grass rats (*Arvicanthis niloticus*). All objectives were met.

ACTIVITIES

Administrative and Fiscal Details

The PACD, which was extended until December 31, 1992, should permit DWRC to accomplish most of the Project's objectives and expected outputs. A Limited Scope Grant Agreement (LSGA) was rewritten and submitted for signatures and the Project Implementation Letter (PIL) will be amended. A budget for the approximate $54,000 retained by the AID/N'Djamena Mission was prepared to fund field operations and training workshop expenses.

Following interviews, a new driver was hired under a Purchase Order. He has extensive prior driving experience and is an excellent mechanic. The vehicle was serviced, a new battery purchased, and the insurance paid.

Two more TDY's were tentatively planned, one for the period of about October 10 to November 10 and a second one from November 20 to December 15 to conclude the field work and close out the Project. Detailed work plans for Dr. Angaya were prepared, discussed, and agreed upon. Each TDY'er will reactivate the Project field and laboratory activities along the lines of these workplans. The Project vehicle will be available for these TDY'ers, but it will be garaged with AID in the interim.

Field Research

N'Gouri

A copy of the N'Gouri trip report of August 22-24 is attached (Attachment 1). To summarize: we trapped unstriped grass or Nile rats (*Arvicanthis niloticus*) and fringe-tailed gerbils (*Tatera robusta*) alive at the Ghoural wadi from dense, thorny fencerows. Almost all adult female unstriped grass rats (4 of 5) were pregnant, 1 littered 7 young on the 24th of August, 1 littered on the 25th, and 1 littered on the 28th. This suggests that breeding may have been intense in the first week of August at this wadi. We captured 5 Egyptian or Anderson's gerbils (*Gerbillus andersoni*) in snap traps and caught one alive by digging it out from its burrow. Fourteen animals were returned alive to our N'Djamena facility. The millet fields near N'Gouri are in excellent condition, and residual soil moisture is good. This year appears to be headed towards an excellent one for rodent populations.

Karal/Beltram

A copy of the Karal trip report is attached (Attachment 2). To summarize: we trapped in a millet field near Beltram and caught 3 Anderson's gerbils and 1 slender gerbil (*Taterillus* spp.) in 35 effective trap nights. Effective trap nights are those traps that are not sprung or lost overnight, plus those that capture some animals. This is the first record of slender gerbils from this area. At Beltram village, we placed 15 live traps and 30 snap traps with villagers with the help of the local Secours Catholique pour le Developpement (SECADEV) agents. We captured 11 multimammate rats (*Mastomys [Praomys] natalensis*) from houses and grain stores. Five of these rats were returned alive to our N'Djamena facility.

At Karal, we gave advice on how to deal with a bat infestation at the Agricultural Cooperative Development International (ACDI) Guesthouse to Claudio and Kathy Sagui, and we measured 30% bird damage to a maize field west of Beltram.

Gassi Seed Farm

Two trips were made to the MOA's Gassi Seed Production Farm, about 15 km east of N'Djamena. Live traps (30) set in dense vegetation near the storage buildings caught 2 shrews (*Crocidura flavescens*) and 1 hedgehog (*Erinaceus albiventris*) overnight on August 20. On September 3 we caught 1 roof rat (*Rattus rattus*) and 2 multimammate rats in 48 live traps set overnight (6% trapping success), while 6 of 36 tracking tiles set were positive (17%) for footprints. The seed farm has excellent vegetation around the buildings and in the fields, so we expected to trap unstriped grass rats here, but did not.

Laboratory Toxicity Studies

LD_{50} Studies

The toxicity for several Chadian rodent species of chlorophacinone and bromadiolone, both products of LIPHA, Lyons, France, were investigated. These rodenticides are the anticoagulants most likely to be found in the markets in Chad, since they are French-derived. The approximate LD_{50} of chlorophacinone for unstriped grass rats obtained from N'Gouri and those previously trapped from Walia was done by stomach gavage of the material dissolved in mineral oil. Three dose levels, 0.7 mg/kg, 1.4 mg/kg, and 2.8 mg/kg, were given for 3 consecutive days to 2 randomly selected rats at each level. Mortality was observed for 10 days following the test. Results were (No. tested/No. dead):

0.7 mg/kg/ x 3 = 2/2
1.4 mg/kg/ x 3 = 2/2
2.8 mg/kg/ x 3 = 2/2

Based upon these findings, the approximate LD_{50} would be less than 3 daily doses of 0.7 mg/kg. This indicates that unstriped grass rats feeding on baits containing 0.005% chlorophacinone would require only 3 days for complete mortality. The average daily consumption of 4-5 g of bait by each animal would give a 3-day intake of 6.0 to 7.5 mg/kg of chlorophacinone, far more than a lethal dose.

To give a better perspective on these findings, the often-quoted lethal value for warfarin for wild Norway rats (*Rattus norvegicus*) is given as 1 mg/kg/day for 5 days. This means that chlorophacinone is much more toxic for unstriped grass rats than is warfarin for wild Norway rats.

Attempts were made to dose bromadiolone to unstriped grass rats, but the suspension of the concentrate (mixed with wheat flour) in mineral oil blocked the gavage needle, so no tests were done.

Feeding Tests

Chlorophacinone and Bromadiolone

Two groups of multimammate rats (*M. natalensis*) grouped 3 to 6 animals per cage were offered chlorophacinone (0.005%) and bromadiolone (0.005%) mixed with 2% mineral oil and whole millet for 2-4 days.

These findings indicate that both chlorophacinone and bromadiolone at 0.005% concentration in food baits could be expected to give excellent kills when fed to multimammate rats for 3-4 days in the field. With chlorophacinone, the first deaths occurred on Day 2 of the trial, and the mean days to death were 3.7 days (range 2-8

days). For bromadiolone, the first death occurred on Day 3 and the mean days to death were 5.3 (range 3-6 days). Results are shown as follows:

Toxicant	No. rats	No. dead	Mean wt (g)
Chlorophacinone:			
2 days	5	3	44
3 days	4	4	54
4 days	3	3	52
Bromadiolone:			
2 days	6	4	48
3 days	5	5	44
4 days	5	5	66
Reference: (10 days)	5	0	54

Zinc Phosphide

Two groups of multimammate rats, caged 7 rats to each group, were given a choice between millet baits with 2% peanut oil, with and without an added 1% zinc phosphide. In the first group, 2 rats were killed (28%), after having eaten an average of 89 mg/kg of the poison. The group consumption of plain bait was 12.0 g and consumption of the poison, 1.1 g. In the second group, 3 rats were killed from an average intake of 31 mg/kg of the poison. The group ate 9.0 g of plain bait and 0.44 g of poison.

Eight individually caged multimammate rats were given a 1-night feeding choice of millet baits containing 2% peanut oil and with (poison bait) or without (plain bait) 1% zinc phosphide with the following results:

Animal No.	Sex	Weight (g)	Amount of bait eaten (g) Plain	Poison	Result	Dose of ZnP (mg/kg)
1	M	74	0.16	0.08	Escaped	?
2	M	74	0.0	0.93	Dead	123.7
3	F	50	0.51	0.62	Dead	124.0
4	F	51	0.0	0.75	Dead	150.0
5	F	51	0.23	Spilled	Alive	?
6	M	65	0.21	Spilled	Dead	?
7	M	68	Spilled	Spilled	Dead	?
8	M	48	Spilled	0.25	Alive	52.5

The zinc phosphide killed 5 out of the 7 rats exposed to it. The dose of zinc phosphide eaten ranged from 52 to 150 mg/kg, and while the animal eating 52 mg/kg survived, the 3 rats eating 124 to 150 mg/kg all died. This preliminary test shows that multimammate rats will eat zinc phosphide baits and are susceptible to doses exceeding 100 mg/kg.

Another 3 individually caged multimammate rats and 3 individually caged fringe-tailed gerbils were offered 1% zinc phosphide in a free-choice test as above. These results were obtained:

Species	Animal No.	Sex	Weight (g)	Amount of bait eaten (g) Plain	Poison	Result	Dose of ZnP (mg/kg)
Multi-	1	M	48.5	1.4	0.0 *	Dead	?
mammate	2	F	48.7	4.4	0.24	Alive	48.0
rats	3	F	43.3	0.0	0.30	Dead	69.3
Fringe-	4	M	87.4	2.5	0.0 *	Dead	?
tailed	5	F	93.5	5.9	0.07	Alive	7.5
gerbils	6	M	103.3	2.1	0.04	Alive	3.3

* Bait consumption could only be measured accurately to ±0.02 g.

These observations on multimammate rats, combined with the above previous test, indicate that 1% zinc phosphide may not be a very good concentration to use against this species. Combining the two tests, 7 out of 10 animals were killed by an intake of 69 to 150 mg/kg, while 3 animals survived; 2 of these had an intake of 48 to 52 mg/kg of zinc phosphide. The acceptance of zinc phosphide by the multimammate rats was fair. Two of 3 fringe-tailed gerbils refused the zinc phosphide or ate so little they were unaffected. All 3 animals ate more of the plain bait. This raises the interesting speculation that where the two species occur together, zinc phosphide baits would kill unstriped grass rats but would spare fringe-tailed gerbils due to their refusal to eat the baits. Since fringe-tailed gerbils rarely are a pest species, this is an obvious advantage.

Four individually caged unstriped grass rats were given a free-choice of plain and zinc phosphide-poisoned millet baits with 2% peanut oil for 1 night. Results are given in the table below:

Effects of 1% zinc phosphide baits on unstriped grass rats:

Animal No.	Sex	Weight (g)	Amount of bait eaten Plain	Poison	Result	Dose of ZnP (mg/kg)
1	M	121	3.53	0.20	Alive	16.6
2	F	109	0.67	0.53	Dead	48.8
3	F	102	0.23	1.21	Dead	118.6
4	F	86	1.90	0.65	Dead	75.4

It appears that zinc phosphide may have about the same toxicity for unstriped grass rats as it does for Norway rats, approximately 40 mg/kg. There does not appear to be any aversion by unstriped grass rats to eating zinc phosphide baits. The 1% concentration should prove adequate in the field.

Workshop on Rodent Research and Control

A 5-day workshop was held for personnel of Private Voluntary Organizations, Non-Governmental Organizations, and the Chad Ministry of Agriculture and Rural Development on September 8-12, 1992, at the Novotel, N'Djamena. The workshop was opened by the AID Representative, Ms. Anne Williams, and the Minister of Agriculture, Dr. Bambe Dansala. The course coordinators, Dr. Richard Dolbeer, Dr. Maho Angaya, and I, used as many local examples as possible while developing workshop materials during the 2 weeks preceding training. Color photographs were taken of the local rodent species and displayed as 24- by 30-cm enlargements at the workshop. Live animals were used to show the field characteristics of each species. Demonstrations were made of capture-mark-recapture methods, stomach gavage of poisons, trapping rodents, mixing and handling of baits, collecting and preparing animal specimens, and assessing bird and rodent damage to crops in the field.

Fifteen participants attended from nine different areas of Chad (Attachment 3). Lively discussions were held with the participants regarding vertebrate pest problems in their areas. Almost all agreed that postharvest losses in storage (instead of preharvest field losses) were currently major problems with rodents. About 77% of the participants reported having rodents in their households. A variety of other vertebrate pests were also of concern. Desert hares apparently caused serious damage to winter vegetable crops during the general rodent irruptions during 1986 to 1989. Monkeys were a problem in maize fields near Bol during the ripening stage in September and October. Several participants reported that jackals seriously damaged melons in season.

The training manual was completed and bound on September 10, so copies were then handed to all participants. The manual and other visual materials have regional value for all Sahelian countries. It may be possible to have the manual printed in its French version. All French issues of "Rat Facts" were given out. Laboratory and field exercises gave the participants a chance to have "hands on" training. A field day at the Gassi Seed Farm provided the participants an opportunity to set traps and use tracking tiles in rodent activity measures.

The Novotel provided excellent accommodations for the workshop. It should be commended for its fine service. The office/laboratory of the Project was used for the afternoon sessions involving live animals and mixing of baits, etc.

The lectures and demonstrations were given by the three course coordinators, Dr. Dolbeer, Dr. Angaya, and Mr. Brooks. Dr. Dolbeer and Mr. Brooks worked through an interpreter, who translated each lecturer's English into French and the participants' French responses and questions back into English. This worked reasonably well, except that the amount of material to be presented of necessity had to be shortened. Dr. Angaya gave his lectures in French and, consequently, he was able to cover considerably more material in his allotted time. Overall, the material presented in the training manual was more than adequately covered during the 5 days of the workshop.

The expenses for the training course ran approximately $2,000 for rental of the conference room from the Novotel, $500 for the development of visual aids, $1,500 for all the participants' per diem and transportation, $600 for portfolio carriers for the participants, $800 for course materials, $400 for interpreter services, and about $200 for miscellaneous expenses, totaling $6,000 for the 5-day course.

RECOMMENDATIONS

(1) These TDY's of Mr. Brooks and Dr. Dolbeer should, if possible, be followed by two more consultancies: one in October/November and another in November/December, to finish the field work and close out the Project. This would permit meeting most of the Project objectives.

(2) Research on toxicity of rodenticides should be completed with the field tests to be carried out by Dr. Dolbeer at N'Gouri. However, a test protocol for Dr. Angaya was prepared, and he should continue to carry out laboratory tests on live multimammate rats and unstriped grass rats as they are collected alive and returned to the facility.

(3) A continuing study of the breeding and population dynamics of multimammate rats in N'Djamena should be done by Dr. Angaya during the next year, if possible. Rodents can be trapped from households by giving traps to neighbors and friends and collecting the captures the following day. Data collected from these animals will give information on the breeding and seasonal changes in the population of this common house-dwelling rat in the city. This kind of information on the multimammate rat is extremely rare from this area. A protocol for this study was prepared and discussed with Dr. Angaya.

(4) The training manual has regional value and should be reformatted in its French version and printed for distribution to countries throughout the Sahel. The visual materials developed, along with the training manual, provide a complete training package.

(5) Information on rodent damage to vegetable crops in the winter season should be collected during the November/December TDY.

(6) If time permits, assessments for bird damage to maize and millet should be obtained during the current season. Chad was the original location of the United Nations Food and Agriculture Organization (FAO) quelea research project, which began in 1968-69 and continued in Chad until 1978. Much information on bird pests of Chad and a great deal of Africa has already been collected. It should be available on microfiche from FAO Headquarters in Rome.

ACKNOWLEDGMENTS

I want to especially commend Dr. Maho Angaya for the excellent and painstaking translation he did for the training manual. I recommend the very fine accommodations at the Catholic Mission Guesthouse in N'Djamena, and I appreciate the assistance provided to us by Dezoumbe Djonret, Assistant Agricultural Development Officer (ADO); Son Nguyen, Project Manager; and Dr. Trid Mukherjee, ADO. We appreciated the hospitality of the AID Representative. Our special thanks to Dr. Anita Mackie and her husband, Mr. Darrel Plowes, for their kind hospitality and help in putting the training course together.

The AID Translator, Mr. Souleyman Caman, assisted translating parts of the training manual into French, which is much appreciated.

Dr. Tigaye N'Doubabe provided able assistance from the Ministry's side for the workshop, which is acknowledged. We thank the Ministry and the Direction of Crop Protection for assigning another technician, Mr. Djimtouloum Gonbeloum, to us for the time while Mr. Djibo Koulangar was in Germany for his training.

The kindness of the Sous-Prefecture at N'Gouri is acknowledged. To the Office for Rehabilitation Through Training (ORT), Mr. Tony Johnson, Mr. Firmin Mansis, and Mrs. Wendy Asher, many thanks for use of their facilities at N'Gouri, without which much of the field work would have been very difficult. The same is true for Mr. John Smith (ACDI, N'Djamena) and the Saguis (ACDI, Karal) for their excellent hospitality.

This was a difficult but very satisfying TDY in many ways. Arriving in a strange country, carrying out field work on weekends, and putting together the endless details of the workshop were taxing in the extreme. But everything came together during the 5 days of the workshop and, personally, this TDY was a fine experience.

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Mr. Suliman Mahamat

TRIP REPORT--N'GOURI

We traveled to N'Gouri on August 22-24, 1992. The purpose of the trip was to activate research studies again at N'Gouri after a lapse of 9 months and to gather specimens of rodents for the upcoming workshop. Both objectives were met. I was accompanied by Dr. Maho Angaya, Project Assistant, and our newly hired driver, Mahamat El-Hadji N'Gaba. We stayed at the ORT guest house. On arrival we had tea and then opened up our storage at Mr. Oustache's house and retrieved several hundred snap traps. We were accompanied in the field by Mahamat Beshir. Our first stop was the dunes above the wadi of Brodou. We set a line of traps in a millet field (CE)[1] and a parallel line in the noncultivated dune (NE)[2]. Some burrows of fringe-tailed gerbils (*Tatera robusta*) were evident in the millet field, but many burrow openings of Egyptian or Anderson's gerbils (*Gerbillus andersoni*) were seen in the non-cultivated dune area. Much of this is due to the millet field being denuded of vegetation (from the farmers' weeding) except for the millet. The noncultivated parts of the dune had a sparse covering of herbs, weeds, and grasses, providing a more favorable habitat for the gerbils. We further set 20 "special" traps (10 mouse and 10 rat) around *G. andersoni* burrows near the NE trapline. We drove to a nearby dune, Yym-Yym, and set one line of traps on the noncultivated dune. By this time, darkness was setting in.

On August 23, we had no captures on the Yym-Yym trapline. In Brodou on the dune, we caught 2 *G. andersoni* on the CE line, none on the NE line, and 2 more *G. andersoni* in the "special" traps. Of 250 traps set, about 240 could have been effective (not sprung or missing), and we captured 2 animals. In 20 "special" traps, which had been deliberately set to capture gerbils, we caught 2 gerbils. We dug into 4 *G. andersoni* burrows in attempts to find some alive, but didn't see any. However, all had *Tribulus terrestris* seeds stored in dry sand inside the burrows.

About 9 a.m. we traveled to Goural wadi, about 4 km from N'Gouri, to trap unstriped grass rats (*Arvicanthis niloticus*). Here, in hedgerows and around palm trees with dense ground vegetation, we set 45 live traps, Japanese and Tomahawk. We also set two lines of 25 each of rat snap traps in the hedgerows. We hired a boy to watch the traps and put any captured rats into the shade. Before we left, we caught one *A. niloticus* alive. We caught 9 more *A. niloticus* that day, but one died before we returned to the guest house. We set 2 lines of 50 traps each (25 rat and 25 mouse) in CE habitat above the wadi. Burrows of *G. andersoni* were not nearly so numerous as near Brodou. When we dug up one *G. andersoni* burrow, the animal came shooting out of a nearby bolt hole (another exit to the burrow)--we cornered him under a shrub and caught him alive. We finally returned to the dune area near Brodou and set 25 "special" mouse traps near *G. andersoni* burrows.

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[1] CE = a cultivated area, exterior to the wadi, located up on the surrounding dunes

[2] NE = noncultivated area, exterior to the wadi, located up on the surrounding dunes

At Goural wadi the next day, we captured nothing in the 2 lines in the CE. We had only 1 *A. niloticus* in the 50 snap traps and only 1 sprung trap. In the live traps, we caught 3 *T. robusta*, 1 *M. natalensis*, and 2 *A. niloticus* (1 more escaped), a total of 17 rats in the live traps versus 1 in the snap traps. One *A. niloticus* littered 8 young in the trap overnight and a second littered in a trap with 2 other animals, but only 3 young were seen, 2 of which were dead. At least 3 other *A. niloticus* females were suspected of being pregnant. We returned 10 *A. niloticus*, 3 *T. robusta*, and 1 *M. natalensis* to N'Djamena alive. At Brodou in the NE area, we captured 1 more *G. andersoni*. The gerbil females were pregnant.

We dug up 12 *G. andersoni* burrows in attempts to catch gerbils, but without success. However, all had storage chambers containing the same *T. terrestris* seeds, and the remains of discarded seeds were seen at burrow entrances. The stomachs of the gerbils were filled with seed material. Gerbils store the seeds in dry sand inside the burrows. The dry sand is easily distinguished from the moist sand, which is found beginning about 10 to 15 cm under the surface.

Total Trapping Results

SNAP TRAPS (set in traplines):

Brodou	50 traps in CE	= 2 *G. andersoni*
"	50 " " NE	= 0
Yym-Yym	50 traps in NE	= 0
Goural	100 traps in CE	= 0
"	50 traps in hedgerows	= 1 *A. niloticus*
	300 snap traps	= 3 captures

"SPECIAL" TRAPS (live and snap, not in traplines):

Brodou	45 "special" traps	= 3 *G. andersoni*
Goural	45 live traps }	= 13 *A. niloticus* (1 escaped)
	}	= 3 *T. robusta*
	}	= 1 *M. natalensis*
	90 "special" traps	= 20 captures, of which 17 were in live traps baited with fresh maize or potato.

The millet is about 1 m tall, heading out, and flowering. Soil moisture appears adequate, and this should be a good harvest. A large outpouring of young rats should be apparent in about 6 weeks (about the beginning of October). To take advantage of this potential rodent population increase after 2 years of absolute population lows, I would recommend 3 areas of research for the next 3 months: (1) use an activity measure for estimating relative density of *A. niloticus* and *T. robusta*, such as tracking tiles set in lines in hedgerows, along with live traps to catch animals for reproductive

studies; (2) use burrow counts along 6 m-wide transects about 250 m in length to estimate relative density of *G. andersoni* and *T. robusta* in cultivated and noncultivated areas on the dunes (set "special" traps at burrows of each species to catch animals for reproductive studies); and (3) continue to dig up burrows of *G. andersoni* to find what food items are being stored each month from September through December. The burrow count transects could be laid out as permanent transects or they could be selected randomly on dunes each trip. I would recommend permanent transects. ANOVA could be used to analyze results from each month's counts. The counts should show an increase between now and December.

TRIP REPORT--KARAL

I traveled to Karal on August 29-30, 1992, accompanied by Dr. Richard Dolbeer, DWRC Wildlife Biologist, and Mr. Maho Angaya, Project Assistant. I arrived at the Agricultural Cooperative Development International (ACDI) Guesthouse at 12:30 p.m. and was invited to lunch by Claudio and Kathy Sagui, joined by Mr. Kip Harkness (Peace Corps Volunteer, Karal). During lunch, a thunderous rainstorm came for about 1 hour.

At 2:00 p.m. we departed for the fields. We picked up some snap traps from our Secours Catholique pour le Developpement (SECADEV) storage in Karal. Mr. Kip Harkness accompanied us. We set two lines of 50 traps each (25 rat and 25 mouse), one in a millet field and one in grassland about 5 km west of Karal. We traveled onward to Beltram and arranged with the three SECADEV agents to have traps set in houses and grain stores at Beltram. We left 15 live traps, 15 rat traps, and 15 mouse traps there.

About 1 km east of Beltram, we set a line of traps in a millet field where there was sandy soil with a few burrows of gerbils visible. Darkness was coming on, so we returned to ACDI/Karal.

In traps set at the first site, we had no captures. In the trap line at Beltram we caught 1 *Taterillus* and 3 *G. andersoni*. The *Taterillus* female was pregnant with 6 young (10-mm CR [crown-to-rump length]). We dug up several gerbil burrow systems and recovered a hoard of seeds of *Acacia nilotica* from one burrow system. The traps given at Beltram caught 11 *M. natalensis*, 5 alive and 6 dead, including 4 immatures easily confused with *Mus*. We took body measurements to be certain. We returned to Beltram about 12:30, had lunch, and departed for N'Djamena about 3 p.m. We arrived at the office at 5:30 to feed and water the 5 live rats.

This is the first record of *Taterillus* at Karal. This specimen weighed 64 g and the tipoff was the large ears, measuring 22 mm (widely spaced on the head, like on some bats). I think we have caught some on previous trapping here, but misidentified them as *G. andersoni*.

All rats from the village, both from the grain stores and the houses, were multimammate rats. The females are easily identified by the numerous nipples. The immatures could have been mistaken as *Mus*, except the hind foot is too long.

At the ACDI guesthouse, we examined the roof and attic area for an owl roost and discovered that they had a bat colony over the office area. We gave Claudio and Kathy advice on how to wait until the bats leave at night and then seal their entry holes into the attic. We recovered a few pellets of a barn owl.

Measurements of Rodents from Beltram, near Karal, Chad

Species	Sex	Wt	HBL*	Tail	H. Foot	Ear	Remarks
Mastomys natalensis	M	92	147	130	27	20	-
" "	F	50	121	122	27	18.5	20 mammae
Taterillus spp.	F	45	129	152	30	22	Preg. 6 embryos
Gerbillus andersoni	M	26	95	120	26	15	Immature
" "	F	21	92	118	26	-	Immature
" "	M	33	102	133	30	16	Scrotal

* HBL = head and body length.

PARTICIPANTS IN THE RODENT RESEARCH AND CONTROL WORKSHOP

	Noms et Prenoms	Service	Lieu D'excercice
1.	Nadjaldongar Kladour	SECADEV	N'Djamena
2.	Abel Noubadeur	SECADEV	Mongo
3.	Moussa Moussaye	ORT	N'Gouri
4.	Dapsia Madjirembe	DPV	Lai
5.	Koutchianki Mady	DPV	N'Djamena
6.	Adoum Abanga	CARE	Chaddra
7.	Oumarou Mbaidom	CHARB	Bouguimen
8.	Ismael El Faki	DPV	Adre
9.	Mamadou Hassane	SODELAC	Bol
10	Abdoulaye Adami	SODELAC	N'Gouri
11.	Djimtouloum Gonbeloum	DPV	N'Djamena
12.	Tigaye Ndoubabe	DPV	N'Djamena
13.	Assane Nadjo	CARE	Kim
14.	Momian Ngarsari	ONDR	N'Djamena
15.	Ndoukor Ben Benam	DPV	Bousso

Attachment 4

WORKSHOP ON RODENT RESEARCH AND CONTROL
SPONSORED BY USAID, THE CHAD MINISTRY OF AGRICULTURE
AND THE USDA/DENVER WILDLIFE RESEARCH CENTER
NOVOTEL, N'DJAMENA, CHAD
8-12 SEPTEMBER 1992

TUESDAY - 8 SEPTEMBER

8:00 - 8:30 **REGISTRATION**

8:30 - 9:00 **OPENING CEREMONIES**
- AID Representative, Ms. Anne Williams
- The Minister of Agriculture, Dr. Bambe Dansala

9:00 - 9:30 **INTRODUCTION TO THE WORKSHOP**
- Objectives of the workshop
- Problems of rodents in the Sahel

9:30 - 10:15 **RODENT SYSTEMATICS**
- Classification of rodents
- General morphology of rodents

10:15 - 10:45 **BREAK**

10:45 - 12:00 **IDENTIFICATION OF SAHELIAN RODENTS**
- *Arvicanthis niloticus*
- *Mastomys [Praomys] natalensis*
- *Tatera robusta, Taterillus, Gerbillus andersoni, Jaculus*
- *Mus* sp.
- *Rattus rattus*

12:00 - 2:00 **LUNCH**

2:00 - 4:30 **LABORATORY SESSIONS**

- Examination of rodent specimens and skulls
- Demonstration of live rodents and insectivore specimens
- Identification of rodent species and their field characteristics
- Necropsy of rodents
  Internal organs, pregnancy, body measurements
- Demonstration of population estimation (capture-mark-release methods)

WEDNESDAY - 9 SEPTEMBER

8:00 - 9:00 **RODENT BIOLOGY**
- Reproduction and growth
- Population dynamics
- Mortality factors
  - Diseases and parasites
  - Predators

9:00 - 10:15 **RODENT BIOLOGY**
- Food habits
- Home range
- Burrow systems
- Habitats

10:15 - 10:45 **BREAK**

10:45 - 12:00 **RODENT POPULATION MONITORING METHODS**
- Trapping
- Burrow counts
- Headlight surveys
- Other activity measures

12:00 - 2:00 **LUNCH**

2:00 - 4:30 **LABORATORY SESSIONS**

- Types of traps, snap and live-capture
  How and where to set them
- Mixing baits and precautions (demonstration)
- Handling and placing baits (demonstration and practice)
- Effects of rodenticides (demonstration of poisoned rats
  with necropsy)

THURSDAY - 10 SEPTEMBER

8:00 - 12:00 **FIELD SESSION**

8:00 - 8:30 - **INTRODUCTION** (Novotel Conference Room)

8:30 - 12:00 - Gassi Seed Farm
- Damage assessment methods
- Setting traps
- Placing baits
- Population monitoring methods
- Tracking tiles
- Food consumption

2:00 - 4:30 **RODENT SPECIMEN COLLECTION**
- Collection methods
- Preparation of specimens
  - Stuffed skin, flat skin, skull

FRIDAY - 11 SEPTEMBER

8:00 - 10:30 **FIELD SESSION**

10:30 - 11:00 Return to Novotel

11:00 - 12:00 **DISCUSSION OF FIELD RESULTS**

12:00 - 2:00 **LUNCH**

2:00 - 4:30 **LABORATORY SESSION**

- Miscellaneous
  - Continuation of specimen preparation, poison dosing, necropsy, mixing baits, damage assessment, etc.
  - Bird damage problems, mylar ribbon

SATURDAY - 12 SEPTEMBER

8:00 - 8:45 **RODENT CONTROL METHODS**

- Nonchemical methods
  - Household sanitation
  - Habitat manipulation
  - Physical barriers
  - Trapping
  - Other methods (encouraging predators, acoustic, etc.)

8:45 - 9:30 **CHEMICAL METHODS**

- Rodenticides, acute and chronic
- Effect of rodenticides
- Toxicity of poisons

9:30 - 10:15 **CHEMICAL METHODS**

- Baits and bait materials
- Mixing and handling baits
- Baiting methods (burrows, containers)

10:15 - 10:45 **BREAK**

10:45 - 12:00 **CLOSING CEREMONIES**

- Awarding of certificates
- Closing remarks/AID Representative, Ms. Anne Williams
- Close of the workshop/Minister of Agriculture, Dr. Bambe Dansala

*RODENT CONTROL TRAINING AND RODENTICIDE FIELD TRIALS IN CHAD**

TRIP REPORT

26 AUGUST - 27 SEPTEMBER 1992

Richard A. Dolbeer
Project Leader

Ohio Field Station
Denver Wildlife Research Center
Animal Damage Control
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
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Unpublished Report

7 October 1992

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RODENT CONTROL TRAINING AND RODENTICIDE FIELD TRIALS IN CHAD-
TRIP REPORT (26 AUGUST - 27 SEPTEMBER)

Richard A. Dolbeer, U. S. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Ave., Sandusky, OH USA.

INTRODUCTION AND OBJECTIVES

The Chad Rodent Control Research Project was initiated by the Denver Wildlife Research Center in October 1989 and field work on rodents in the Sahel region was carried out until the departure of the resident Project Leader, J. J. Spillett, in early December 1991. No field work was subsequently done until the arrival of J. E. Brooks from the Denver Wildlife Research Center on 11 August 1992. Maho Angaya, the Project Assistant hired 2 weeks prior to Spillett's departure, carried out limited laboratory work in the interim but spent most of his time translating into French all project documents as well as the training manual drafted by J. E. Brooks.

J. E. Brooks was in Chad from 11 August to 13 September 1992. The objectives of his trip were to 1) reactivate the project by preparing budgetary and administrative details in agreement with USAID/Chad and developing work plans for the project through the completion date of 31 December 1992, 2) revisit project sites at N'Gouri and Karal to obtain information on the status of rodent populations in preparation for rodenticide field trials, 3) prepare and present a 5-day seminar on rodent control and research techniques in N'Djamena to Chadians from various private and government organizations involved in agricultural production, and 4) conduct laboratory toxicity studies of rodenticides on multimammate rats (*Mastomys natalensis*) and unstriped grass rats (*Arvicanthis niloticus*). All objectives were met and have been documented (Brooks 1992).

The objectives of my overlapping trip to Chad from 27 August to 27 September were to 1) assist Brooks in the planning, preparation and presentation of the 5-day seminar, 2) conduct field trials of rodenticides to obtain information on bait acceptance by rodents, efficacy in reducing rodent populations, and hazards to nontarget species, and 3) continue collecting data on the biology and status of rodent populations in the Sahel region of Chad. In addition, I had the opportunity to make limited observations and assessments of bird damage to

agricultural crops and provide some training in bird damage control. My trip itinerary is listed in Appendix A.

RESULTS

Seminar on Rodent Research and Control

Brooks (1992) has documented the success of the 5-day seminar (8 - 12 Sept. 1992), in which 15 participants from 9 locations in Chad received training via lectures, hands-on laboratory work, practical field demonstrations, and a comprehensive training manual. Although there were many administrative and logistical obstacles and challenges in organizing and presenting the seminar (e.g., locating various instructional supplies in N'Djamena, not to mention dealing with a planned national workers strike and a major religious holiday during the week of the seminar), we had 100% attendance and excellent attentiveness and response by the participants. The closing ceremony, in which certificates were presented to participants and speeches were made by the USAID Representative and the Minister of Agriculture and Rural Development, was covered by Chadian television and radio. The seminar was personally a rewarding experience.

Brooks (1992) has already provided details on the seminar participants and course of instruction related to rodents. Because there was considerable interest by the participants in bird damage to agricultural crops, some seminar time was devoted to this topic which I will summarize here. A demonstration was given on the deployment of mylar ribbons and eye-spot balloons to frighten birds in grain fields. Each participant was given a 100-m roll of ribbon to take home and use as a demonstration project in a local field of millet or sorghum. A bird-resistant variety of millet, with bristles (awns) protecting the grain, was compared with a bird-susceptible variety during a lecture session. Then, a damage assessment demonstration was conducted in a ripening millet field at Gassi Seed Farm 15 km from N'Djamena in which a sample of 100 heads from bird-susceptible varieties averaged 24% (SD=27%) loss of grain to birds (73% of the heads were damaged). An examination of 20 heads of the above-described resistant variety in an adjacent plot revealed no damage.

Field Research-Karal/Beltram

Brooks (1992) documented the results of this 2-day trip (29-30 Aug) in which field and village rodent trapping was conducted. In addition to the rodent work, we located a ripening maize field west of Beltram within a few kilometers of Lake Chad in which 44 of 150 ears examined (29%) were damaged by birds. Damaged ears averaged about 25% of the grain destroyed, indicating a total loss of grain in the field of about 7%. The damage appeared to be at least several days old and we saw no flocks of birds in the field; thus, the species responsible for the damage was undetermined. I did note red bishops (Euplectes orix) nesting around the maize field. Wet ground prevented us from driving closer to Lake Chad to examine other maize fields.

Field Research-Gassi Seed Farm

Brooks (1992) documented rodent trapping and monitoring results on 20 August and 3 September from this farm about 15 km E of N'Djamena. Additional trapping and monitoring were done on the night of 10-11 September as part of the training seminar. The results from all 3 nights are summarized in Table 1. Snap traps were baited with peanut butter and live traps (approximately equal numbers of Tomahawk and Japanese) were baited with potatoes or fresh sections of maize on the cob. Overall, only 3 rodents (2 Mastomys natalensis and 1 roof rat [Rattus rattus]) were captured in 176 trap-nights. Three shrews (insectivores) were also captured and 10% of the tracking tiles (15 x 15 cm white linoleum with 1/2 of the surface coated with a thin layer of a 90% mimeograph ink-10% peanut oil mixture) showed small mammal tracks. The seed farm had dense vegetation around the buildings and agricultural fields but no unstriped grass rats were trapped or observed.

As noted above in the Seminar section, grain loss to birds of 24% was estimated in 1 ripening millet field at the seed farm. Damage appeared to be primarily by village weavers (Ploceus cucullatus) although other species of small birds, including cut-throat weavers (Amadina fasciata), were also observed in the field. The farmer was attempting to protect the 0.5-ha field with a rather elaborate system of metal cans containing pebbles suspended at millet-head height from ropes strung from poles

throughout the field. One person, who apparently guarded the field throughout the day, could rattle all of the cans by pulling on a main rope from the field edge.

Field Research-N'Gouri

Field work was conducted near N'Gouri, about 200 km from N'Djamena on the NE side of Lake Chad, from 15 - 22 September. We conducted rodenticide field trials in 4 wadis (interdune depressions or oases where hand irrigation from shallow wells is used to grow grain and vegetable crops). We also monitored rodent populations and made notes of birds in the wadis and on the dune areas surrounding the wadis where dryland cultivation of millet is undertaken. Bird observations were made to obtain information on species causing agricultural damage and on species that might be impacted by rodenticide baitings.

Rodenticide trials-- A 1% zinc phosphide (ZP) bait was prepared by mixing 1 part ZP formulation (96% ZP) with 94 parts millet and 1 part peanut oil. A 0.005% Chlorophacinone (CP) bait was prepared by mixing 1 part CP formulation (0.28% CP in mineral oil) with 55 parts millet. The bait was mixed 4 to 6 days before using and stored in clearly labeled, heavy plastic bags.

The 4 wadis selected for the trials were within 5 km of N'Gouri. All were oval shaped, about 200 to 250 m long by 100 to 150 m wide, and surrounded by thorn fences 0.5 to 1 m high and 0.5 to 1.5 m wide. Each wadi was inspected before the trial began to look for rodent activity (cut vegetation, pathways in thorn fence); to ask the local farmer if rodents were a problem; and, if conditions appeared satisfactory, to obtain permission from the farmer to run the trial. The baiting and monitoring procedure was explained to the farmer and his field workers, they were warned about the rodenticide bait, and they were asked to look for sick or dead rodents and birds during the trial.

In each wadi, 50 stations for monitoring and baiting rodents were established at 10-m intervals along a 500-m section of the thorn fence that appeared to have the most rodent activity (generally about 50 to 75% of the total length of the fence was covered). Pretreatment monitoring of rodent activity was done by placing on the ground in the thorn fence at each station a tablespoon (about 15 g) of untreated millet in a pile, a tracking tile, and a snap and/or live trap for 1 or 2 nights. We placed

these materials in runways whenever possible and tried to place the bait deep enough in the thicket to be inaccessible to birds. Traps, tiles and bait were checked daily. The amount of bait removed was estimated in 25% increments (0, 25, 50, 75, 100% removal) and replenished to the original amount when $\geq$ 50% was removed. The observer noted if insects appeared responsible for bait removal. Tracking tiles were examined for the presence of rodent track(s) which, if present, were wiped clean with a cloth.

After the pretreatment period, baiting with rodenticide was conducted for 3 to 4 nights in the 2 wadis treated with ZP and for 4 to 5 nights in the 2 wadis treated with CP. Treated bait was placed and monitored in the same manner as done for the untreated millet. A 1- to 2-night posttreatment monitoring period using tracking tiles and traps was then conducted in each wadi. Observers looked for sick or dead rodents and other wildlife as they walked through the wadis and alongside the thorn fences daily in their inspections of the baiting and monitoring stations. In addition, the perimeter and interior of each wadi was searched for 1.5 to 2.0 person-hours (4 to 5 people each searching 20 to 30 minutes) during the posttreatment period.

Overall, bait acceptance by rodents appeared good during both pretreatment and treatment periods. During pretreatment, 36 to 88% of the stations had $\geq$ 25% of the millet removed overnight, apparently by rodents (Tables 2-5). During the first 2 nights of the treatment period, 28 to 64% of the stations had $\geq$ 23% of the bait eaten overnight in the CP-treated wadis (Tables 2, 3) and 40 to 52% had bait eaten in the ZP-treated wadis. Insects (primarily ants and beetles) removed $\geq$25% of the bait at about 5% of the stations.

Wadis with ZP-treated millet showed a greater reduction in rodent activity posttreatment than did wadis with CP-treated millet. Bait piles eaten declined from 50 and 88% during the pretreatment period to 4 and 8% on the last day of treatment for the 2 ZP-treated wadis. Positive tracking tiles declined from 42% in both wadis during pretreatment to 2-9% during posttreatment. Captures in snap traps were also down from 8 and 22% pretreatment to 2 and 0% posttreatment (Tables 4, 5).

For CP-treated wadis, bait consumption showed no consistent pattern of decline during the 5-day treatment period compared to the pretreatment levels. Positive tracking tiles actually

increased from 8% pretreatment to 18% posttreatment in 1 wadi (Table 2) and decreased from 28% to 8% in the other wadi (Table 3). Captures in live traps did show a decline from 12 and 18% pretreatment to 0% posttreatment.

A total of 26 rodents was trapped in the 4 wadis in 523 trap nights (221 live traps, 277 rat snap traps, 25 mouse snap traps). Species composition was Arvicanthis niloticus (65%), fringed-tailed gerbils (Tatera robusta) (19%), naked-sole gerbils (Taterillus sp.) (12%) and ground squirrel (Xerus erythropus) (4%) (Table 6).

One dead rodent and 1 dead bird were found in the wadis during the treatment-posttreatment period. In Kaya Wadi (Table 4), 1 dead Tatera robusta was found on 19 September (2 days after ZP-treated millet placement) at a burrow entrance about 5 m from the thorn fence. An autopsy revealed Zn-treated millet in the stomach. In Goural Wadi (Table 2), a pigeon-sized bird (as yet unidentified to species), was found on 22 September (6 days after CP-treated millet placement). An autopsy revealed only insects in the stomach and no evidence of hemorrhaging or liver discoloration. Thus, it is doubtful that this mortality was related to the treatment.

In conclusion, the rodenticide field trials indicated that 1% ZP-treated millet can be used in Wadi thorn fences to reduce rodent populations. There was no evidence of mortality to nontarget species in the ZP trials. For CP, the test results were not clear-cut. Although bait acceptance appeared good, feeding and tracking tile activity did not show consistent declines after 5 days of baiting. Because CP is a slow acting anticoagulant toxicant, perhaps significant mortality did not occur until 6 or 7 days after feeding when our posttreatment evaluations were terminated. Additional, longer-term field studies are needed to clarify this issue.

Miscellaneous rodent monitoring activities-- We placed mouse snap traps overnight in 6 dune areas and rat snap traps in 1 of these areas. In 281 trap nights, we captured 8 sand gerbils (Gerbillis andersoni) (Table 6). This low trap success was somewhat surprising because most traps were placed near what appeared to be active burrows of Gerbillis andersoni or jerboas (Jaculus jaculus).

We conducted 3 roadside censuses by vehicle at night near N'Gouri to count rodents. Surprisingly, although no Jaculus jaculus were captured in snap traps in the dunes, this species was commonly seen at night along the road, averaging 4 individuals/km (Table 7). Jaculus appeared to be most common in areas of sparse vegetation such as where millet fields were adjacent to the road. We found them relatively easy to capture by hand; 12 were captured in this fashion, primarily by Maho Angaya.

We excavated 2 burrow systems of Gerbillis andersoni in the dunes on 15 September and found 3 juveniles in each. These 6 gerbils were kept in captivity during our stay in N'Gouri. We found that they highly preferred grasshoppers as a food to rice or maize. They would aggressively attack and eat grasshoppers placed in the cage. Arvicanthis, Tatera and Jaculus in captivity did not exhibit this behavior toward insects.

We monitored 1 pitfall trap (a clay container about 50 cm deep and 30 cm in diameter at the opening) which had been installed in the ground next to the thorn fence in Goural wadi sometime previous to our arrival. The trap contained water about 10 cm deep. One juvenile Arvicanthis was captured over the 8-day period of monitoring.

Table 8 summarizes reproductive data for adult female rodents autopsied. Data are meager for Tatera and Arvicanthis because most individuals of these species were captured in live traps in wadis during the rodenticide trials and marked and released.

Bird damage--There was considerable bird activity in and around many of the upland (dune) millet fields which were beginning to ripen in mid-September. Because of above-average rainfall this year, the ripening millet crop was considered outstanding by the local farmers. Golden sparrows (Passer luteus) were common in the area, often seen in the millet fields and in thorn trees where they were nesting. Other finch-like birds were also present in the millet but our impression was that Passer luteus was the most common bird. In spite of the bird activity, virtually no bird damage was noted in 10 millet fields that I walked through on the dunes. Perhaps bird damage will occur in October as the crop reaches final maturity. Bird damage was obviously of concern to farmers because most fields had some

type of scarecrow or flagging to frighten birds. The only significant bird damage I noted was to a small (10 x10 m) plot of mature millet in Guini wadi. Here, 26 heads examined averaged 61% of the grain removed by birds.

Comparison of rodent monitoring methods

Overall, snap traps appeared to be the least effective means of monitoring rodent populations, both at Gassi Seed Farm (Table 1) and around N'Gouri (Table 6). At Gassi, snap traps had 0% capture success compared to 4% for live traps and 10% for tracking tiles. At N'Gouri in the wadis, rat snap traps had a 1.4% success rate compared to 10.0% for live traps and 17.5% for tracking tiles. In the dunes, where snap traps were placed primarily around active burrows, trap success was only 3.3%. When the data from Gassi and N'Gouri are combined, there are significant ($P \leq 0.01$) differences in success among tracking tiles (16.7%), live traps (7.8%) and snap traps (1.9%) (X_2 = 83.5, 2 df, Table 9). Brooks (1992) also noted much better success with live traps than with snap traps at N'Gouri in August 1992.

Acknowledgements

I especially commend Dr. Maho Angaya for the excellent translation he did for the training manual, for the outstanding job of helping to organize and lead the seminar, and for his expertise and enthusiasm in the field work. I recognize Joe Brooks for his leadership and professionalism in the seminar and for his advice and assistance in preparing me for the field work. I also commend our driver, Mahamet El-Hadji N'Gaba, for his driving skills and able assistance with the field work. Working with these 3 people was a rewarding and pleasurable experience during a very challenging assignment.

I appreciate the assistance provided by Dezoumbe Djonret, Assistant to the ADO, and by Trid Mukherjee, ADO at USAID. I appreciated the hospitality of the AID Representative, Anne Williams. A special thanks goes to Darrel Plowes for his kind hospitality.

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The kindness of the Sous-Prefecture at N'Gouri is acknowledged. To ORT personnel Tony Johnson, Firmin Mansis and Wendy Asher, much thanks for use of their facilities at N'Gouri, without which much of the field work would have been very difficult. The same thanks go to John Smith (ACDI) and the Sagui's at Karal for their excellent hospitality.

Persons Contacted

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LITERATURE CITED

Brooks, J. E. 1992. Chad Rodent Project: Administration, research and training. Unpublished trip report (9 Aug-13 Sep), U.S. Dept. of Agric., Denver Wildlife Research Center, Denver, Colorado 80225, USA. 15pp.

Table 1. Small mammal trapping and monitoring effort and success for live traps, snap traps, and tracking tiles set overnight in dense vegetation next to agricultural fields, in a seed storage warehouse, and in a millet-okra field at Gassi Seed Farm 15 km east of N'Djamena, Chad, 1992.

		Live traps		Rat snap traps		Mouse snap traps		Tracking tiles	
Date	Habitat	No. of traps	No. of captures (% success)	No. of traps	No. of captures (% success)	No. of traps	No. of captures (% success)	No. of tracking tiles	No. (%) marked
20 Aug	Field edge	30	3 (10)[a]						
3 Sep	Field edge	38	2 (5)[b]					36	6 (17)
	Storage	10	1 (10)[c]	5	0 (0)	5	0 (0)		
11 Sep[d]	Field edge	25	0 (0)			25	0 (0)	24	0 (0)
	Millet-okra field	23	0 (0)						
	Storage	10	0 (0)	5	0 (0)				
Total		136	6 (4)	10	0 (0)	30	0 (0)	60	6 (10)

[a] Two shrews (*Crocidura flavescens*), 1 hedgehog (*Erinaceus albiventris*).

[b] Two *Mastomys natalensis*.

[c] One *Rattus rattus*.

[d] Heavy rain (>25 mm) during the night of 10-11 September may explain the total lack of trapping and tracking success on this date.

Table 2. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Goural Wadi near N'Gouri, Chad during field trial of chlorophacinone (CP), 16 to 22 September 1992.

	Pretreatment activity (16-17 September)			Treatment period bait consumption (CP-treated bait piles eaten[a] [N=50])					Posttreatment activity (21-22 September)		
	Bait piles eaten[a] (N=50)	Positive tracking tiles (N=100)	Captures in live traps (N=50)	Sep 17	Sep 18	Sep 19	Sep 20	Sep 21	Positive tracking tiles (N=100)	Captures in: live traps (N=20)	Captures in: snap traps (N=50)
No.	18	8	9[b]	19	32	38	28	20	18	0	1[c]
%	36	8	18	38	64	76	56	40	18	0	2

[a] At least 25% of bait pile removed overnight.

[b] Five _Arvicanthis niloticus_, 2 _Taterillus_ sp., 1 _Tatera robusta_ and 1 _Xerus erythropus_. Seven of the 9 were marked and released.

[c] One _Tatera robusta_.

Table 3. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Assakandori Wadi near N'Gouri, Chad during field trial of chlorophacinone (CP), 17 to 22 September 1992.

	Pretreatment activity (17 September)				Treatment period bait consumption (CP-treated bait piles eaten[a] [N=50])					Posttreatment activity (22 September)	
	Bait piles eaten[a] (N=25)	Positive tracking tiles (N=50)	Captures in snap traps (N=25)	Captures in live traps (N=25)	Sep 18	Sep 19	Sep 20	Sep 21	Sep 22	Positive tracking tiles (N=50)	Captures in live traps (N=20)
No.	10	14	0	3[b]	14	28	22	18	10	4	0
%	40	28	0	12	28	56	44	36	20	8	0

[a] At least 25% of bait pile removed overnight.

[b] Two Tatera robusta and 1 Taterillus sp.. One of the Tatera was marked and released.

Table 4. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Kaya Wadi near N'Gouri, Chad during field trial of Zinc Phosphide (ZP), 17 to 22 September 1992.

	Pretreatment activity (17 September)			Treatment period bait consumption (ZP-treated bait piles eaten[a] [N=50])				Posttreatment activity (21-22 September)	
	Bait piles eaten[a] (N=25)	Positive tracking tiles (N=50)	Captures in snap traps (N=25)	Sep 18[b]	Sep 19	Sep 20	Sep 21	Positive tracking tiles (N=100)	Captures in snap traps (N=50)
No.	22	21	2[c]	25	29	28	2	9	1[d]
%	88	42	8	50	58	56	4	9	2

[a] At least 25% of bait pile removed overnight.

[b] Three Arvicanthis niloticus caught in 25 live traps set during first night after Zn-treated bait was placed. One of the trapped animals was dead in trap and Zn-treated millet was found in stomach. The other two captured rats were marked and released.

[c] Two Arvicanthis niloticus.

[d] One Arvicanthis niloticus.

Table 5. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Guini Wadi near N'Gouri, Chad during field trial of Zinc Phosphide (ZP), 19 to 22 September 1992.

	Pretreatment activity (19 September)			Treatment period bait consumption (ZP-treated bait piles eaten[a] [N=50])			Posttreatment activity (22 September)		
	Bait piles eaten[a] (N=50)	Positive tracking tiles (N=50)	Captures in snap traps (N=18)	Sep 20	Sep 21	Sep 22	Positive tracking tiles (N=50)	Captures in live traps (N=18)	Captures in snap traps (N=50)
No.	25	21	4[b]	20	21	4	1	1[c]	0
%	50	42	22	40	42	8	2	6	0

[a] At least 25% of bait pile removed overnight.

[b] Three _Arvicanthis niloticus_ and 1 _Tatera robusta_ captured. One _Arvicanthis_ was marked and released.

[c] One _Arvicanthis niloticus_ captured.

Table 6. Trapping effort and success for live traps, rat snap traps and mouse snap traps in 4 Wadi and 6 dune locations near N'Gouri, Chad, 16 to 22 September 1992.

	Live traps			Rat snap traps			Mouse snap traps			Tracking tiles		
Habitat	No. of trapping sessions[a]	No. of trap nights	No. of captures (% success)	No. of trapping sessions[a]	No. of trap nights	No. of captures (% success)	No. of trapping sessions[a]	No. of trap nights	No. of captures (% success)	No. of tracking sessions	No. of tracking-tile nights	No. marked (% success)
Wadis	10	221	22 (10.0)[b]	7	277	4 (14)[c]	1	25	0 (0)	11	550	96 (17.5)
Dunes	0	0	0 (0)	1	35	0 (0)	6	246	8[d] (3.3)	0	0	0 (0)
Total	10	221	22 (10.0)	8	312	4 (1.3)	7	271	8 (3.0)	11	550	96 (17.5)

[a] Number of nights in which 18 to 50 traps or tracking tiles were placed in a Wadi or dune.

[b] Fourteen Arvicanthis niloticus, 4 Tatera robusta, 3 Taterillus sp., and 1 Xerus erythropus.

[c] Three Arvicanthis niloticus and 1 Tatera robusta.

[d] Eight Gerbillis andersoni.

Table 7. Nighttime census of rodents within 10 km of N'Gouri conducted by driving vehicle along road at 5-20 km/hr and counting rodents observed in headlights.

			Total number observed (number/km)			
Date	Start time	Distance covered	*Jaculus jaculus*	*Gerbillis andersoni*	*Tatera robusta*	All species
14 Sep	1900	10 km	40 (4)[a]	15 (1.5)[a]	2 (0.2)	57 (5.7)
18 Sep	1930	5 km	25 (5)[b]	2 (0.4)		27 (5.2)
20 Sep	1930	5 km	14 (2.8)[b]	2 (0.4)		16 (3.2)
Total		20 km	79 (4.0)	19 (1.0)	2 (0.1)	100 (5.0)

[a] On the first night, we probably misidentified some Jaculus as Gerbillis.

[b] On these 2 nights we hand-captured 11 Jaculus by chasing them on foot with a flashlight.

Table 8. Reproductive information for adult female rodents captured and autopsied at N'Gouri, Chad, 15-22 September 1992.

Species	No. of adult females autopsied	No. pregnant	Litter size x	SD	(range)
Jaculus jaculus	5	1	4	0	(4)
Tatera robusta	2	1[a]	6	0	(6)
Gerbillis andersoni	9	7[a]	5.6	1.2	(4-7)
Arvicanthis niloticus	1	0[a]	0		
Xerus erythropus	1	0[a]	0		

[a] The females that were not pregnant had recently given birth and were lactating.

Table 9. Overall comparison of snap traps, live traps and tracking tiles for monitoring rodent populations at Gassi Seed Farm (Table 1) and N'Gouri (Table 6), Chad, August - September 1992.

Monitoring method	No. of trap or tracking nights	No. of captures or positive tracks	% success
Live traps	357	28	7.8[a]
Snap traps	623	12	1.9[a]
Tracking tiles	610	102	16.7[a]

[a] The ratio of successful to unsuccessful trap or tracking nights is significantly different among the 3 methods (X_2 = 83.5, 2 df, $\underline{P} < 0.01$)

Appendix A. Trip itinerary for Richard A. Dolbeer

Dates	Locations	Activity
26-27 August	Sandusky, OH to N'Djamena, Chad	Travel via Cleveland, New York City and Paris
27-28 August	N'Djamena, Chad	Prepared for training workshop
29-30 August	Karal, Beltram	Field studies
31 Aug.-7 Sep.	N'Djamena, GASSI	Prepared for training workshop Prepared for field studies
8-12 September	N'Djamena, GASSI	Presented training workshop
13 September	N'Djamena	Prepared for field studies
14-23 September	N'Gouri	Field Studies including rodenticide field trial
24-26 September	N'Djamena	Project administration, data analysis, seminar presentation
27 September	N'Djamena to Sandusky, OH	Travel via Paris, New York City, and Cleveland

Trip Report*

BROWN TREE SNAKE ACTIVITIES IN GUAM AND SNAKE MEETING IN OKINAWA, JAPAN

September 16-October 1, 1992

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Chemical Development/Registration Section

for

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Unpublished Report

November 3, 1992

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ITINERARY

Date	Location	Activity
Sep 16	Denver, Colorado, to San Francisco, California, and Honolulu, Hawaii	Travel
Sep 17	Honolulu, Hawaii, to Guam	Travel
Sep 18-24	Guam	Attended USDI Activities Meeting for the Department of Defense (DOD) Legacy Demonstration Project and assisted U.S. Fish and Wildlife Service (USFWS) research personnel in initiating a Brown Tree Snake field study.
Sep 25	Guam to Okinawa, Japan	Travel
Sep 26-30	Okinawa, Japan	Attended meeting of the "US-Japan Joint Congress on Snake Control for Human Health and Wildlife Conservation"; visited snake research laboratory at the Okinawa Prefectural Institute of Public Health (OPIPH); and toured a Habu snake field operational program.
Oct 1	Okinawa, Japan, to Osaka, Japan, San Francisco, California, and Denver, Colorado	Travel

INTRODUCTION

My activities in this report were initiated by invitation from Dr. Thomas H. Fritts, U.S. Fish and Wildlife Service (USFWS), Washington, D.C., and by Dr. Yoshio Sawai, Japan Snake Institute, Japan. The two objectives were to attend the Legacy Demonstration Project Meeting in Guam that was organized by Dr. Fritts and to participate in the meeting "US-Japan Joint Congress on Snake Control for Human Health and Wildlife Conservation" (Snake Control Congress) in Okinawa, Japan, that was chaired by Dr. Sawai and cochaired by Dr. Fritts. These activities are related to the involvement that the Denver Wildlife Research Center (DWRC) has had with the USFWS for development of effective control techniques that can be used as part of an integrated pest management system for control of Brown Tree Snakes (*Boiga irregularis*) on Guam.

Fritts (1988) has reviewed the Brown Tree Snake problem on Guam and other Pacific islands. The Brown Tree Snake is a significant, mildly venomous, exotic pest that was probably introduced on Guam via military cargo from Papua New Guinea after World War II (Fritts, 1988). This snake was detected on Guam in the 1950's, became conspicuous in the 1960's, and is presently distributed throughout the island with population densities estimated to be several thousand per square mile in some areas. The Brown Tree Snake has probably been the primary factor for the extirpation of several bird species on Guam, and it threatens several others (Savidge, 1987). These snakes are agricultural pests and will kill chickens, pigeons, caged song birds, newborn pigs, kittens, and puppies.

GUAM ACTIVITIES

I. Legacy Project:

On September 18, I attended a briefing organized by Dr. Fritts on proposed activities related to the Legacy Demonstration Project. The Legacy Project is funded by the Department of Defense (DOD) for cultural and conservation projects on land controlled by the military and is providing support to USFWS (Dr. Fritts) to evaluate techniques for creating snake-free areas. The briefing was attended by representatives from the U.S. Navy, U.S. Air Force, USDA/Plant Protection and Quarantine, and the public news media.

About one-third of the land on Guam is controlled by the military, and some of this land has high populations of Brown Tree Snakes. Trapping and barriers to snake movements will be the two primary methods evaluated by USFWS researchers to establish snake-free zones. The initial work will be conducted on 1-ha plots with expansion to 10-ha plots as experience is gained in the development of workable techniques. The barrier will be an electrified exclosure fence with "hot" wires on the outside to prevent entry of snakes from

the outside. However, snakes inside the exclosure will be able to crawl out. Snake traps will also be utilized inside the fence for snake removal. Population indices of nontarget animals (e.g., birds and lizards) will be recorded for control and test plots to assess effectiveness of the techniques used.

There was also a site visit on Andersen Air Force Base where the trapping and barrier work will be conducted by the USFWS. Potential challenges for establishing an effective barrier include a shallow soil with underlying limestone which will require much effort to anchor the fence posts; uneven terrain; damage to the fence caused by deer, pigs, and hurricanes; and heavy vegetation that may have to be controlled with a herbicide to prevent electrical shorting of the wires.

II. Evaluation of Odor Attractants

I assisted USFWS researchers in establishing a snake census trapline from September 21 to 24. Dr. Gordon Rodda is the study director for this project which is designed to evaluate the effectiveness of odor attractants for catching Brown Tree Snakes in live traps under field conditions. Several attractants including predator scents and lures have been initially screened in the laboratory under the supervision of Dr. David Chiszar at the University of Colorado, Boulder. Development of a good odor attractant would make a significant advance in trapping snakes.

OKINAWA ACTIVITIES

I. Okinawa Prefectural Institute of Public Health (OPIPH)

The purpose of the Snake Control Congress in Okinawa was to provide an exchange of information between American and Japanese researchers involved in snake control. The Habu (*Trimeresurus flavovirdidis*) is a poisonous snake found on the Amami and Okinawa Islands of Japan and is controlled for human safety reasons (Tanaka *et al.*, 1987). Although the Brown Tree Snake and Habu are quite different in their biology, there are common aspects of control techniques for both snakes that could be utilized by either the American or Japanese personnel.

Prior to the Snake Congress meeting of September 27 to 30, Dr. Thomas Fritts arranged for a September 26 informal meeting of American researchers with personnel from the Department of Habu, OPIPH. The Department of Habu has well-equipped indoor and outdoor facilities for evaluating artificial baits, repellents, attractants, and barriers, and much of their effort is devoted to Habu control under field conditions with nonelectrified barrier fences and live traps. Dogs for detecting (sniffing) Habu are also trained at this facility.

During this meeting, discussion revolved around about the similarities and differences between the Habu and Brown Tree Snake. The common denominators for control of these snakes are the use of barriers and traps, but these two techniques vary according to the snake. A nonelectrified fence (barrier) is effective for the Habu, but the Brown Tree Snake might climb over this type of fence so that electrified fences might be required. Live traps for Habu are placed on the ground, but traps placed about 4-6 ft from the ground in trees are effective for Brown Tree Snakes. Participants agreed that an effective synthetic lure would be highly desirable to attract snakes into traps. Department of Habu personnel have tested several repellents, but none were considered to be of practical value.

II. Snake Control Congress

The program and list of participants for the "US-Japan Joint Congress on Snake Control for Human Health and Wildlife Conservation" is presented in Appendix 1. Thirty-three (33) papers were presented; the topics included biology, human health considerations, feeding habits, movement patterns and ranges, trapping techniques, barrier (electrified and nonelectrified fence) designs, pheromones, repellents, attractants, and toxicants. Of particular interest was information provided on a new snake toxicant (Habu-Knock®[1]) manufactured by Sumika Life-Tech., Matsuura Sakaisuji Building, 9-28, 1-chome, Kyutaro-cho, Chuo-Ku, Osaka, 541 Japan. Habu-Knock is an aerosol product that contains a synthetic pyrethrin as its active ingredient and a synergist. It is a dermal toxicant that produces death in about 2-4 hours and can be used in narrow spaces to kill snakes that would be difficult to capture. I made a presentation entitled "Candidate repellents, oral and dermal toxicants, and fumigants for Brown Tree Snakes."

A symposium volume of contributed papers from the presenters will be published. This volume will contain historical as well as the most recent materials used for the management of snakes. A recommendation was made to hold a second joint congress in 2 years, most likely in the United States.

III. Habu Field Trip

On September 30, the Department of Habu, OPIPH, hosted a Habu field trip and visit to a reptile park. Harborage for the Habu included dense vegetation in close proximity to human dwellings. At one site, a nonelectrified barrier fence was being used to exclude Habu from areas near dwellings, and live traps were used inside the fenced area. Despite these control efforts, several Habu

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

had been caught within the past months. Numerous Habu are on Okinawa, and the land is extensively used for agriculture (sugarcane fields, vegetable gardens). Consequently, many humans (estimates are 200-500 per year) are bitten by Habu, but the death rate is low because of good anti-toxin and medical treatment. The venom from one Habu is enough to kill two to three people within 24 hours.

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US-JAPAN JOINT CONGRESS ON SNAKE CONTROL FOR HUMAN HEALTH AND WILDLIFE CONSERVATION

Program and Abstracts

September 27–30, 1992

OKINAWA CONVENTION CENTER

GINOWAN CITY, OKINAWA, JAPAN

PROGRAM

September 28

1.	8:40	The biology of the brown tree snake, *Boiga irregularis*, super predactor or successful opportunist	T. H. Fritts*, M. J. McCoid and G. H. Rodda
2.	9:20	The biology of the habu	Y. Hayashi
3.	9:40	Movement patterns, activity ranges and hunting behaviour of *Boiga irregularis* (Reptilia, Colubridae). An introduced predator on the island of Guam.	M. A. Santana-Bendix* and O. E. Maughan
		Coffee Break 10:00—10:30	
4.	10:30	Why is habu so dangerous? An evolutionary consideration	M. Toriba
5.	10:50	Dispersal of snakes to extralimital islands.	T. H. Fritts* and M. J. McCoid
6.	11:10	Introduced reptiles and amphibians of the Ryukyu archipelago, Japan.	H. Ota
7.	11:30	Food habits of feral mongoose (*Herpestes* sp.) on Amami-oshima island.	S. Abe* Y. Handa, Y. Abe, Y. Takatsuki and H. Nigi
		Lunch 11:50—13:30	
8.	13:30	A historical outlook of the studies on habu (*Trimeresurus flavoviridis*) bites in Japan.	Y. Sawai
9.	14:10	Circumstances and symptoms of snakebite by the brown tree snake in Guam.	T. H. Fritts* and M. J. McCoid
10.	14:30	The brown tree snake and electrical power grids: shorts, faults, and solutions.	T. H. Fritts* and D. Chiszar
		Coffee Break 14:50—15:20	
11.	15:20	Histology of sensory organs of habu.	K. Hirosawa* and S. Takami
12.	15:40	Venom delivery by the brown tree snake, *Boiga irregularis*, and the habu, *Trimeresurus flavoviridis*.	K. V. Kardong
13.	16:00	Seasonal changes of spermatogenesis and ultrastructure of seminiferous epithelium in the habu, *Trimeresurus flavoviridis*.	M. Kurohmaru*, S. Hattori and Y. Hayashi

		Coffee Break 16:20—16:40	
14.	16:40	An integrated pest management plan for the brown tree snake on Pacific islands.	E. W. Campbell III*, T. H. Fritts, G. H. Rodda and R. L. Bruggers
15.	17:10	Areas of occurrence of habu bites indicated by the factorial analysis and transfer of cognition for high risk sites among dwellers.	H. Tanaka* and Y. Hayashi
16.	17:40	Population trends and limiting factors.	G. H. Rodda*, M. J. McCoid and T. H. Fritts

September 29

17.	8:40	Trapping the brown tree snake.	G. H. Rodda*, T. H. Clark and S. W. Gotte
18.	9:00	A field experiment with removing all habus, *Trimeresurus flavoviridis*, from the residential area with traps.	H. Shiroma* and H. Akamine
19.	9:20	The feasibility of controlling the brown tree snake in small plots.	G. H. Rodda*, T. H. Fritts and E. W. Campbell III
20.	9:40	Ten years removal of habu, *Trimeresurus flavoviridis*, by trap in a small island, Minna-jima, in the Okinawa islands.	S. Katsuren, C. Yoshida* and M. Nishimura
		Coffee Break 10:00—10:30	
21.	10:30	Barriers to movements of the brown tree snake (*Boiga irregularis*).	E. W. Campbell III
22.	10:50	Effect of the improvement of the habitual environment on the population of habu (*Trimeresurus flavoviridis*) on the Tokunoshima island of Japan.	S. Mishima*, Y. Hayashi and Y. Sawai
23.	11:10	A method for protecting nests of the Mariana crow from brown tree snake predation.	C. F. Aguon*, R. E. Beck, Jr. and M. W. Ritter
24.	11:30	Roosting behavior of the Okinawa rail.	K. Ozaki* and T. Harato
		Lunch 11:50—13:30	
25.	13:30	Chemical control of predatory behavior in the brown tree snake (*Boiga irregularis*).	D. Chiszar

26.	14:10	Collection and analysis of airborne odorants from rat materials.	T. Niwa*, S. Hattori, H. Kihara, T. Sato and S. Murata
27.	14:30	The isolation and chemical characterization of skin lipid pheromones in the brown tree snake, *Boiga irregularis*.	R. T. Mason
		Coffee Break 14:50—15:20	
28.	15:20	Trap-capture for habu, *Trimeresurus flavoviridis*, with odor extracted from rats.	S. Hattori*, Y. Noboru, H. Kihara and Y. Hayashi
29.	15:40	The possible use of haemogregarine parasites in biological control of brown tree snakes and habu.	S. R. Telford
30.	16:00	Review of studies on artificial food and repellent to control habu, *Trimeresurus flavoviridis*.	M. Nishimura
		Coffee Break 16:20—16:40	
31.	16:40	New method and materials to prevent venomous snakes.	M. Toriba*, S. Senbo and Y. Kosuge
32.	17:00	Candidate repellents, oral and dermal toxicants, and fumigants for Brown Tree Snake control.	P. J. Savarie* and R. L. Bruggers
33.	17:20	Dog training for searching habu.	H. Ukuda and H. Shiroma*

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Trip Report*

VERTEBRATE PEST MANAGEMENT IN TROPICAL ASIA

August 26-September 29, 1992

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Unpublished Report

December 23, 1992

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LAOS:

"Rats are one of the major pests in upland rice and it is highly probable that it is significant in other countries of the region."
- J. Schiller, 6-1-92, Team Leader, Lao-IRRI Project

MALAYSIA:

"Due to rat depredations ... vast tracts of rice lands have had to be abandoned."

"Rats caused 35% of the total crop damage ... (more than) birds and insects." - Y. M. Lam, 1991, MARDI Rice Research Center

INDONESIA:

"... rodents remain pest problem number one for the Indonesian rice grower."

"... farmers could harvest only 10-50% of their potential yield for a number of consecutive seasons." - van Elsen and van de Fliert (FAO), 1991

PHILIPPINES:

IRRI FARM:

"If there is no physical control of rodents then continuing trials on IRRI farm are not possible." - IRRI Researcher, 1991

BANAUE, IFUGAO:

"The worst pest in Banaue for rice cultivation is rats." - Cleto Immatong, IRRI Office, Banaue

"Number one problem pest in Banaue is the rodent." - Emilio Abayao, CECAP Office

ITINERARY

Date	Location	Activity
Aug 26	Denver, Colorado, to Hilo, Hawaii	Travel
Aug 27	Hilo	Reviewed Denver Wildlife Research Center (DWRC) Hilo Field Station project activities, including the recent temporary duty assignment in the Philippines by the Project Leader.
Aug 28-29	Hilo, Hawaii, to Manila, Philippines	Travel
Aug 30	Manila, Philippines, to Los Baños, Philippines	Travel
Aug 31	Los Baños	Met with International Rice Research Institute (IRRI) staff regarding vertebrate pest management in tropical Asian rice.
Sep 1	Los Baños	Met with staff of the University of the Philippines at Los Baños (UPLB) regarding their vertebrate pest management curriculum and the National Crop Protection Center (NCPC) regarding vertebrate pest research and training.
Sep 2	Los Baños to Manila, Philippines	Met with additional IRRI staff before traveling to Manila for a meeting at the Asian Development Bank.
Sep 3	Manila	Visited the Visayas State College of Agriculture (VISCA) Manila Office; attended a debriefing with the U.S. Agency for International Development (USAID), obtained travel clearances, and made arrangements for an Indonesian stop.

Itinerary (Continued)

Date	Location	Activity
Sep 4	Manila, Philippines, to Jakarta, Indonesia, and Jakarta to Bogor, Indonesia	Travel
Sep 5-7	Bogor	Visited the IRRI Liaison Office to arrange Indonesian appointments, spent time report writing; and visited the Central Research Institute for Food Crops, the Bogor Zoological Museum, Bogor Agricultural Institute, and the IRRI Office.
Sep 8-10	Bogor to Bandung, Indonesia	Travel; met officials at Padjadjaran University and the West Java Agricultural Extension Service.
Sep 10	Bandung to Sukamandi, Indonesia; Sukamandi to Jatisari, Indonesia; and Jatisari to Jakarta, Indonesia	Travel within Indonesia; met with officials at the Sukamandi Research Institute for Food Crops Department of Pest and Disease and staff of the Directorate of Food Crop Protection Vertebrate Laboratory.
Sep 11	Jakarta	Visited the Department of Food Crop Protection and the USAID, Office of Economic Support and Policy.
Sep 12	Jakarta to Bangkok, Thailand	Travel; contacted the Ministry of Agriculture (MOA), Crop Protection Department.

Itinerary (Continued)

Date	Location	Activity
Sep 13-16	Bangkok	Visited the MOA, Agricultural Extension Department, Crop Protection Department, Division of Entomology and Vertebrates, Vertebrate Laboratory; IRRI Liaison Office; USAID, Agricultural Development Office; Regional Office of the Food and Agriculture Organization (FAO) of the United Nations; U.S. Embassy, Agricultural Attache Office; and National Institute for Science and Technology Research.
Sep 17-18	Bangkok to Chiang Mai, Thailand	Travel; toured upland rice areas; visited Samoeng Highland and Temperate Cereal Research Station, MOA Department of Extension Plant Protection Service Unit Office, MOA Research Station, postharvest grain storage sites, and Chiang Mai University.
Sep 19-21	Chiang Mai to Kuala Lumpur, Malaysia	Travel; worked on writing reports; and met with personnel of the USDA/Foreign Agricultural Service (FAS)
Sep 21	Kuala Lumpur to Perak, Malaysia	Travel; met with officials at the Malaysian Agricultural Research and Development Institute (MARDI) Cocoa and Coconut Research Center
Sep 22-23	Perak to Penang, Malaysia	Travel; met with officials at the MARDI Rice Research Center

Itinerary (Continued)

Date	Location	Activity
Sep 24-26	Penang to Hong Kong	Travel; met with officials at Pesticide Services, Ltd., and Hong Kong Department of Health.
Sep 27-28	Hong Kong to New Delhi, India	Travel. Met with officials at the U.S. Embassy, Agricultural Attache Office; Indian Council of Agricultural Research; Winrock International Plant Genetics Resources Project; MOA, Plant Protection Adviser, Central Insecticide Board and Registration Committee, Directorate of Plant Protection and Quarantine and Sanitation.
Sep 29-Oct 1	New Delhi to Cairo, Egypt	Travel. Met with personnel from USAID, Agricultural Development Office; MOA, National Agricultural Research Project and Plant Protection Research Institute; Egyptian/German Rodent Control Project; and staff at the Universities of Cairo, Ain Shams, Zagazig, and Alexandria.
Oct 2-3	Cairo to Denver, Colorado, and Bowling Green, Ohio, via Rome, Italy	Travel

EXECUTIVE SUMMARY

Crop protection specialists in six Asian countries, namely the Philippines, Indonesia, Thailand, Malaysia, Hong Kong, and India, were visited to identify the current status of rodent pest management activities and, where appropriate, other vertebrate pests. This information was used to recommend appropriate strategies for improving country and regional pest management programs. Although these recommendations address mostly rodent pest management concerns, they also apply to other vertebrate pests such as birds, wild boar, and porcupines.

Vertebrate pests, especially rodents, were counted among the top three problems in each country visited; and in some, rodents headed the list. However, often the importance of pest vertebrates as crop depredators, environmental degraders, and health hazards is not understood by administrators and the public at large. Nowhere in southeast Asia did we find coordinated teaching/training programs that emphasized vertebrate pests. Not surprisingly, nowhere did we find area control programs for vertebrate pests utilizing integrated pest management principles.

We recommend the following actions be taken utilizing appropriate resources within these southeast Asia countries and the international communities:

Leadership

1. Recognize the need for program leadership and the near-retirement status of many present leaders, and initiate recruitment and advanced training for selected individuals now.

Regional Strategies and Priorities

2. Convene in 1993 a small working conference of indigenous scientists, international experts, and donor representatives to define and prioritize regional research and training needs and plan for the support of initial efforts.

3. This small conference should be followed in a year or so by larger regional conferences and workshops where technical findings can be shared and techniques demonstrated. Proceedings should be published. This should serve as a major communication effort.

Education

4. Representative academics should be invited to a workshop conference in 1993 where curricular programs emphasizing vertebrate pest management (VPM) are presented and strategies for implementing such curricula in various

schools and universities can be planned. Academics themselves must plan these programs and seek introduction into their own institutions. Enhancement of teaching and training programs is required before personnel are available to staff local extension offices and organize control programs.

Regional Training

5. Regional workshops focusing on the practical aspects of VPM are especially needed for training technicians. Professionals from other regions as well as international experts may be involved.

Research Concerns

6. Technical information systems for handling surveillance and monitoring data are needed. Being able to predict seasonal damage patterns and potential degree of losses as well as occasional pest outbreaks may well require such data banks.

7. Applied research related to implementation of management/control practices ("human engineering") as well as adapting ("fine-tuning") existing research and operational knowledge to local needs is generally needed. The role of women and the use of credit are several new areas of concern.

8. Basic research on pest species biology and ecology, except for poorly known species or some minor crop depredations, should have less emphasis.

9. Basic research in some areas (e.g., outbreak prediction, pesticide residues, biochemistry of rodenticide resistance, isolation of natural repellent chemicals) may be quite appropriate and desirable, especially for university settings. Specialized equipment may well be required.

10. Funding support will be needed for each of these identified areas. Significant progress in VPM otherwise will not be made. "Rat farming" at time of crop harvest or responding to outbreak emergencies "after the fact" may well be the alternative.

OBJECTIVES

The purpose of this activity was to (1) identify and describe the current status of vertebrate pest management research and training activities in selected Asian countries and institutes and determine current and future needs, and (2) recommend strategies for addressing these concerns so that appropriate effective integrated rodent pest management technologies can be incorporated into development assistance proposals on a national or regional basis.

The objectives were met by

1. Evaluating:

   (a) The status of national rodent pest management programs including personnel involved, their duties and responsibilities

   (b) Primary rodent/crop problems and successes

   (c) Extension/farmer involvement in implementing rodent control recommendations in field crops

   (d) Regional programs, networking, and information exchange relative to vertebrate pest management within Asian countries

   (e) Government priorities on implementing vertebrate pest management

2. Determining the major research and training needs relative to vertebrate pest management in the region

3. Recommending potential solutions through assistance programs and donor agencies.

ACTIVITIES

Philippines

Grassland species of *Rattus* are responsible for most of the crop damage. *R. r. mindanensis*, *R. argentiventer*, and, to a much lesser degree, *R. exulans*, are the major rodent field pests. Two decades of research and extension work by Philippine Crop Protection experts, assisted by USAID, FAO, and GTZ, led to practical, efficacious, cost-effective, and environmentally sound rodent control methods in many field crops, such as rice, coconut, and maize. However, major improvements still need to be made in the adoption and adaptation of these control techniques by farmers.

International Rice Research Institute (IRRI)

IRRI has functioned as a leading rice research and training center in Los Baños since 1962. Although it has played a major role in crop protection of rice and rice-based cropping systems, until recently vertebrate pest management activities have been restricted to the research farm operations and cooperative

arrangements with other organizations such as the Philippine National Crop Protection Center (NCPC) which have been more directly involved with tropical rodent and bird damage problems.

In 1990, IRRI sponsored a Rodent Pest Management Workshop which focused attention on this major tropical rice pest problem (Quick, 1991). IRRI offered to play the important role of an institutional catalyst to coordinate future rodent and other vertebrate pest control activities. This it has done.

The IRRI Research Farm has implemented a new rodent control strategy. Increased efforts using an integrated pest management (IPM) approach, in part stimulated by the 1990 IRRI rodent workshop, are credited with significant reductions in damage. Major improvements in habitat management, including conversion of open drainage ditches to underground conduits and close cropping of weeds and other perimeter vegetation, have been achieved. Most of the old wire mesh/sheet metal fences (both electrified and nonelectrified) have been removed. Synchronizing planting and requiring fallow periods in May and December also have been incorporated into the management scheme.

First-generation (multiple-feeding) anticoagulants continue to be used in elevated but open bait stations around plots throughout the operations. The efficacy of this technique also needs reevaluation. Under present circumstances, further reduction in chemical reliance might be possible.

The new active barrier system (ABS) has been developed and received preliminary evaluation in experimental plots and now is available (upon request by researchers) for installation with any IRRI experimental plot. The system involves enclosing the area to be protected with a supported plastic sheeting barrier that has multiple-catch trap portals at intervals of about 15 meters (see Appendix A). With proper maintenance, damage within plots has been kept to a minimum; and tiller loss in adjacent, but unfenced plots, has been acceptably low.

Costs for fence installation and maintenance are acceptable at a research facility, but unacceptably high for recommendation to small farmers. Further evaluation through systematic collection of data is needed to document efficacy of this technique and to consider adaptation to the needs of the barrio farmer.

IRRI is open to the suggestion that additional funding be requested as part of its Asian Development Bank (ADB) Phase II application. Such funding could be utilized for further development of the ABS as part of its IPM efforts and to evaluate the effectiveness of the current IPM approach to rodent control on its research farm.

From a regional vantage point, IRRI could readily function in the "training of trainers." In terms of its history as a training center, its staff and facilities for development of documents and teaching tools, and its readily available

experiment/demonstration facilities, IRRI is one of the logical sites for regional activities. Securing funds to support a full-time position (e.g., postdoctoral, visiting scientist) logically would be an initial and critical step.

University of the Philippines at Los Baños (UPLB)

UPLB was established in 1909 as a College of Agriculture to educate students interested in pursuing agricultural careers. In 1972, it became an autonomous university. Other institutions play a major role in other regions of the Philippines and include Central Luzon State University, Visayan College of Agriculture, and the Mindanao College of Agriculture. Within its various colleges, UPLB has incorporated courses that directly or indirectly involve vertebrate pest management. It has graduated students at the M.Sc. and Ph.D. levels with degrees in applied vertebrate zoology. The other Philippine colleges and universities are considerably less involved in vertebrate pest management.

The University, while under an enrollment ceiling of about 8,000, is able to move resources to growing programs, such as in the College of Agriculture. Both degree and nondegree (certificate) programs in pest management flourish, but the emphasis of vertebrate pest management is limited. Greater visibility (and jobs for graduates) is needed.

Cooperation among colleges is evident and might well be enhanced to the benefit of vertebrate pest management. Wildlife Management is taught from the College of Forestry. A 5-year agricultural chemistry degree program and pesticide residue expertise are available in the College of Arts and Sciences. A College of Human Ecology provides environmental impact analysis training in its Department of Community and Environmental Resource Planning. However, in the latter examples, actual utilization is not evident for students specializing in vertebrate pest management.

In the past, numerous students from other countries (including Africa) have been enrolled in these programs (largely in the College of Agriculture); but in recent years, the flow of those with vertebrate pest management needs has nearly ceased.

UPLB encourages visiting scientists from IRRI and other institutions in Los Baños to serve on the faculty as graduate student advisers. Also, Philippine pest management specialists from local institutions, such as NCPC, have taught classes in vertebrate pest and crop protection classes. This cooperation has benefited both national and international students enrolled at UPLB by providing an excellent academic program which included practical laboratory and field research experiences for undergraduate and graduate degree programs, including the Ph.D.

The University administration appears anxious to be an active participant in furthering vertebrate pest management, but leadership at the faculty level (and appropriate travel and research funding) will be required. However, without demand (i.e., national and international students), little is likely to happen.

National Crop Protection Center (NCPC)

NCPC was established in 1976 through a USAID crop protection loan and technical assistance by DWRC. It was a natural outgrowth of the Rodent Research Center that was established in 1968 at Los Baños with the help of USAID and DWRC. Long-term direct support ended in 1983, but occasional technical support continues.

The Center is involved in pest management research and training, but a limited operating budget has required the solicitation of outside funds to support much of this work. Vertebrate pests continue to be an area of emphasis, but work is limited and currently emphasizes the use of botanicals as sources for natural repellents and toxicants for use against rodents and birds. Since the 13 Regional Crop Protection Centers (RCPC's) have been absorbed by local governments, new working relations with the RCPC's have had to be developed by the NCPC.

NCPC, as a research institution, has provided the facilities and technical expertise for UPLB graduate students wanting to work on a specific topic in vertebrate pest management in laboratories or in field crop situations located nearby. Undergraduate students working on special problems in vertebrate pests for classes at UPLB have also occasionally come to NCPC for technical guidance. Unfortunately, these activities have decreased for a variety of reasons discussed above.

Visayas State College of Agriculture (VISCA)

VISCA was established in Leyte to provide an institution for students in the central part of the Philippines pursuing degrees in the agricultural sciences. As at UPLB, a degree program with emphasis on vertebrate pests is possible at this institution. However, recent enrollees in the pest control curriculum have chosen other areas of specialization. Again, job availability would do much to stimulate interest in these courses.

Asian Development Bank (ADB)

The ADB was established in 1966 to provide funds to promote social and economic growth in the region. Member countries contribute funds which are

distributed according to needs that are formally designated by national government organizations.

The Bank is a logical source of funding for proposed regional programs. However, before an application can be successful, it must clearly and convincingly show that rodents (and other pest vertebrates) are creating significant economic losses and that appropriate management tools are available to counter such losses at the farmer level.

Certainly initial applications should be funneled through existing ADB-supported programs, such as at IRRI. Minimum grants are $100,000. Regional Technical Assistance (RETA) may be provided for sectoral studies that include training, conferences and workshops, research, and other regional activities. Small-scale technical assistance also may be provided to assist in project formulation, updating feasibility studies, completing project preparation work, examining specific aspects or sectors relevant to the project, or financing regional activities.

Current interest in upland rice, which is said to have 10% of the cropland but only 5% of the harvest, is strong. Consideration of rodent pest management strategies might well be considered.

INDONESIA

Rodents have long been recognized as a significant crop pest in Indonesia. Annual chronic damage occurs regularly in tidal swamp, deepwater, and lowland rice as well as oil palm, and local "outbreaks" are repeatedly reported. Rice is damaged primarily by *Rattus argentiventer* and *Bandicota indica*, while oil palm is damaged primarily by *R. tiomanicus*. Other crops damaged by rodents are maize, sugarcane, and young rubber trees. The common commensal rodent pest is *R. r. diardii*, but *R. exulans* also invades structures and damages stored foods. Another vertebrate pest of significant economic importance includes the wild boar, particularly among root crops in transmigration (resettlement) areas of southern Sumatra. Despite progress in the 1980's in defining the causes and extent of these problems and proposed practical solutions for individual farms, a national coordinated effort to implement these solutions is still lacking.

International Rice Research Institute Liaison Office, Bogor

IRRI's outreach programs in Indonesia as well as in Malaysia are coordinated through this office. Contact with national agricultural agencies and institutes is an important function that provides for information flow and logistical

coordination for IRRI's headquarter staff and programs. For example, this IRRI office played a key role in establishing contacts and arranging logistics for us to complete our assignment in Indonesia.

Central Research Institute for Food Crops (CRIFC)

CRIFC is a part of the Agency for Agricultural Research and Development (AARD), which is a research branch of the Ministry of Agriculture. CRIFC coordinates activities at six regional research centers, two of which we visited and have described below:

Bogor Research Institute for Food Crops (BORIF)

Located in Bogor, this facility houses the CRIFC headquarters and the Bogor Research Institute for Food Crops (BORIF), one of six regional CRIFC research centers with responsibility for crop protection including pest rodents and other vertebrates. It has been supported by IRRI and the Japanese International Cooperation Agency (JICA) assistance projects that included training in rodent control. Testing rodenticides and presenting papers on rodents at Indonesian pest control conferences are current activities. A recent national survey of agricultural crops had indicated an average 17% loss to rodents. Rodents were considered to be one of the top three agricultural pests, and less than a 10% crop loss due to them would be considered "acceptable" by most farmers.

Sukamandi Research Institute for Food Crops (SRIFC)

SRIFC is located in northern West Java, an area that is regularly subjected to severe rodent crop damage problems. The large research farm has a rodent control officer and staff under Crop Protection whose responsibility it is to limit rodent damage in research plots on the farm. Several "experimental" rodenticides (i.e., ones not registered for use in the country) have been used. An experimental fumigation briquette also has been tested.

In addition, SRIFC responds to complaints from nearby farmers when rodent outbreaks occur. The station is only about 12 km from the Jatisari Research Station of the Directorate of Food Crop Protection (described below), which houses a rodent laboratory and research personnel.

University Involvement

Padjadjaran University (Bandung) is one of the universities providing annual training for extension personnel, but likely it is the only one that includes substantial instruction on vertebrate pests. The principal biology professor there

also works with CRIFC (Bogor) when student research requires additional laboratory facilities. The Agriculture University (Bogor) has an Agriculture Pest Control curriculum; some vertebrate pest instruction is included. The current class is about 30 students.

Agricultural Extension Regional Office, Bandung

Indonesia has had a reputation for one of the finest extension programs in tropical Asia. Regional Extension Heads in Indonesia are given authority to plan and budget much of their own programs. Operational funds are requested and received from National Extension Headquarters in Jakarta, but also the provinces within the Region provide funds for supporting local extension work. Extension agents, referred to as PPL's, are assigned to work directly with farmers. Thirty-six laboratories (for 27 provinces) test and demonstrate new crop varieties and cultural practices and provide specialists to diagnose problems.

Agents have at least high school diplomas, and many have a B.Sc. degree and are schooled in general crop protection and IPM practices. At some point early in their career, they receive a 6-month plant protection course at one of five universities. Those extension trainees who attend Padjadjaran University for this course do get lectures in rodent control, but this is probably not true for those who attend the other universities.

Rodents, more so than insects, are the biggest crop protection problem for extension workers in Central Java. West Java, which accounts for 23% of all rice production in Indonesia, also has major rodent problems, particularly in the coastal rice intensification growing areas.

The Agricultural Extension Service summarized rat damage to surveyed West Java rice fields in recent years as follows:

Year	Total hectarage	Damage intensity (%)
1987-88	23,932	13.3
1988-89	30,068	16.1
1989-90	37,235	15.6
1990-91	36,918	15.7
1991-92	17,165	12.4
Avg	29,064	14.6

This represents an average annual loss of 21,781 metric tons and the reduction of each farmer's income by Rp. 172,366/ha ($85).

A crop surveillance program involves extension workers who report unusual crop protection problems or outbreaks. Pests are monitored on fixed plots in subdistricts every 2 weeks with a walk-through sampling procedure for crop growing areas (farmers are aware of this method and will post signs in their fields to let the workers know that a particular problem is occurring); areas of previous outbreaks are considered suspect and are monitored more closely. While advice is provided to farmers on control programs, local groups have the final authority on activities to be undertaken. Typically, each village has an extension worker.

IPM for rodents has not been developed yet, so extension still relies on rodenticides for management of rodent damage. Klerat®[1] wax blocks are placed in active rodent burrows until harvest when fumigation methods are used. Zinc phosphide is no longer officially used. Agricultural banks can provide credit for rodent control materials, but only the larger farmers can utilize such loans.

Directorate of Food Crop Protection

Food Crop Protection (FCP) headquarters are located in Jakarta where officials administer 36 laboratories, each responsible for testing control methods and developing or using monitoring methods for crop loss assessment, usually over a 6,000- to 10,000-ha area. Crop damage data collected by extension workers are tabulated and summarized.

These FCP laboratories also work closely with local extension offices in developing and testing methods on farmers' fields. Laboratory personnel spend 50% of their time on extension work. Local groups and cooperatives are given advice on when to plant, how to control specific pests, and other crop production and protection concerns. Rodents have been considered a major rice crop pest for many years, but only slow progress has been made in defining the problem and testing potential control methods in farmers' fields.

JICA just completed a several-year crop protection project with Food Crop Protection that included technical assistance in rodent pest management. Also, the FAO recently completed a rodent pest management project which emphasized the involvement of farmers and village residents in managing rodent problems at the local level. BAPPENAS (National Development Planning Agency) works with donors, and all assistance projects must be initiated and implemented through this agency. The current National IPM Program is being coordinated by BAPPENAS with technical support from FAO and a grant from USAID. The 3-year project, which began in 1989, was to train 1,000 pest observers, 2,000 field extension workers, and 100,000 farmers.

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

Jatisari Laboratory

This laboratory at Jatisari in West Java is considered to be a "premier" facility built with JICA support and is much larger than most other FCP laboratories; it services an area of more than 100,000 ha. It housès a forecasting center which accumulates damage assessment data for the purpose of early warning of potential crop pest outbreaks. Extensive studies on rodent population dynamics and trends as well as food habit studies have been completed. Preliminary (flight cage) evaluations of avian predator/prey relationships have been initiated using radiotelemetry. Adoption of rodent control techniques is recognized by this laboratory as a major problem. It spends a considerable amount of time working directly with farmers in an extension capacity.

In early 1992, the Second International Training Course on Pest Surveillance and Forecasting was held at this laboratory, where 15 participants from 9 countries gathered for 6 weeks. One week was devoted to rodent biology, population dynamics, damage, and rodenticide experiments.

Thailand

Thailand has several major rodent pests that damage important agricultural crops. All three bandicoot rat species (*B. bangalensis*, *B. indica*, and *B. savilei*) are present, but *R. argentiventer* and *R. tiomanicus* are responsible for most of the crop damage. *R. exulans* is present as a commensal pest. National rodent damage estimates for rice (6.0% damage), barley (6.5%) and sugarcane (5.3%) are high, as are the estimates for plantation crops like cacao (10.0%), coconut (8.7%), and oil palm (6.0-36.0%).

The upland crop areas of Thailand also are adversely impacted. About 21% of total cropland is damaged, and it is estimated that 34% of this damage is caused by vertebrates, mostly rodents and birds. *B. indica*, *Berylmys* (=*Rattus*) *berdmorei*, *Mus caroli*, and *M. cervicolor* are important rodent species involved.

Ministry of Agriculture

Entomology and Zoology Division, Bangkhen

The Agricultural Zoology Research Group is one of 14 units in this Division. (That it is a distinct unit is a relatively unusual administrative arrangement in a developing country.) Its role is to study animals involved

in crop loss. These include mice, rats, crabs, bats, birds, snails, and slugs. Its long-time Director will leave in September 1992 to join the Du Pont Company. (The corporate raiding of senior government pesticide specialists has resulted from a change in registration regulations that now require (allow) the commercial applicant to conduct his own in-country efficacy trials.) The new Director has been part of the unit and has had specialized training in Europe under GTZ auspices.

The Group has facilities that include an animal room, testing laboratory, museum, and a large conference room. The museum houses a teaching collection of important pest bird and rodent species, but the quality of the specimens is not suitable for research. Current research activities include a cooperative study with Imperial Chemical Industries that is designed to determine whether rodenticide residues are present in rodents being sold at local markets for human consumption.

The staff has carried out an extensive series of laboratory and field investigations (Appendix B). Relatively few have been published. Budgetary support has been reasonably adequate for the present level of operations, but requests for specialized equipment (e.g., telemetry, chemical analytical tools) have been denied.

The Group provides training on pest birds and rodents for international programs of the Ministry and annual training conferences sponsored by Extension as well as for the University's B.Sc. IPM curriculum. Unfortunately, classroom lectures usually are limited to 2 hours; however, laboratory experiences that are somewhat longer are often available. Several Laotian trainees attended recent sessions on vertebrate pest management presented by the Group at the Bangkhen (near Bangkok) facilities; sessions were taught in Thai and English, both of which were understood by the Laotians.

Upland Rice and Temperate Cereals Experiment Station, Samoeng

This station is one of four Ministry of Agriculture substations in Thailand related to upland crops. In addition, it is designated by IRRI for propagation of upland rice varieties, and seeds are distributed to extension agents for sale to farmers. Except for this, there is little interaction of substation personnel with Extension.

Rice, planted at the end of the dry season (since slopes are not accessible during heavy rains), is most susceptible to depredation. The plots are small and scattered, so losses are not consistent yearly.

Losses may be experienced at planting time when rodents dig up the seeds. At the time of Experiment Station planting, Klerat wax blocks may be

broadcast around the field. Some cutting of tillers occurs at the milk stage and into maturity, but generally it is of little concern. Rodenticides are not used by farmers.

Small birds (e.g., *Lonchura* spp.) do serious but inconsistent damage to ripening rice, wheat, and barley. Flocks containing 100 or more birds are common in the dry season crop. Other than traditional scaring devices, no management tools have been available. Mylar tape was suggested by us as a potential counter measure.

In October 1993, demonstration plots of rice varieties are being planned in cooperation with Extension and Nongovernmental Organizations (NGO's--e.g., foreign aid groups). It is suggested that IRRI's plastic fence designs be considered, since the plot size is small (~1 ha) and preventing rodent depredation is desirable.

Soybeans and corn (to a minor extent) are grown in the area, but they have not been affected by vertebrate pests. Root crops (carrots, peanuts) also seem unaffected.

Plant Protection Service Division

The Department of Agricultural Extension has a total group of more than 5,000 workers, each with a minimum of a B.Sc. degree or 5-year vocational certificate, stationed in one of six regions containing a total of 73 provinces. The provinces are grouped into districts and subdistricts. The concept of "training the trainers" is followed at 31 extension centers, one in nearly every district. At village levels, extension agents work with farm leaders (10-20 contact farmers/agent) to have demonstration plantings. Area specialists are available to assist with difficult problems or to provide additional information. Local agents maintain surveillance of pest problems once/month and have the responsibility to take action except in outbreak situations where federal coordination is required. Rodenticides are provided, but only used if necessary. All activities are federally funded.

Training of extension agents occurs at the 17 national universities and more than 30 agricultural vocational colleges. Graduates must pass a government exam. However, no instruction on vertebrate pests is included. The rationale often given is "that farmers are most interested in insects."

Unit 1 Agriculture Extension Office, Chiang Mai

The Chiang Mai operation is one of 7 Units in the Northern Region and is responsible for extension activities in 3 of the 17 provinces, including Chiang Mai itself. Within Unit 1, there are about 727,000 rai

(rai = 0.16 ha) of rice and 441,000 rai of other field crops. Through July of the current reporting period ending in October 1992, 6,179 rai of rice grown by 1,072 farm families were affected by animals (mostly rodents and birds); in other field crops, 8,615 rai grown by 1,382 families were affected by animals. More crop area was affected by vertebrates than either disease or insects.

Table 1. Extension Unit 1 1992 crop damage summary based on preliminary data collected through July.

	Families/Rai* with damage		
	Insect	Disease	Animal
Rice	225/8,750	1,856/4,567	1,072/6,179
Field Crops	1,078/3,722	2,024/7,182	1,382/8,615
Vegetables	469/2,133	145/591	-----

* Rai = 0.16 ha, or 1 ha = 6.25 rai.

The Extension Unit is responsible for providing chemicals during pest outbreaks, which are defined as involving more than 500 rai (80 ha). Integrated pest control demonstration plots, numbering about 30, are maintained; and major crop pest situations are studied and monitored. The office also trains extension workers at the district level. Recommendations for protecting crops are made through radio and television programs and pamphlets. One annual Extension Crop Protection campaign is conducted for 1 week prior to planting time, usually when the rains start in May or June.

Kasetsart University

Faculty of Agriculture

The University, immediately adjacent to MOA facilities just outside Bangkok, in Bangkhen, benefits from cooperative programs. Within the Faculty (College), traditional departments and degree programs exist. A second campus was added in 1979 in Nakorn Prathom Province, about 80 km west of Bangkok.

Unique to this second largest Faculty within the University are the IPM programs, centered administratively in the Department of Plant Pathology. Departmental IPM programs are possible (e.g., Entomology, Plant Pathology, Extension); but in addition, a College IPM (interdepartmental) degree program encompassing these departments plus vertebrate pest

management is offered. The Agricultural Zoology Research Group (described above) provides instruction and related laboratory work. Such cooperation could well be expanded.

Chiang Mai University

No instruction about vertebrate pests or their control is included in any of the University's curricula. However, opportunities certainly exist with present courses--even in "Principles of Insect Control" or "Pest Management"--to include discussions of vertebrate problems. At the graduate level, degree programs in Agricultural Extension and even Public Health and Postharvest Technology offer other opportunities. Similar opportunities probably exist at other colleges and universities for introducing information about vertebrate pests.

Technical Institute of Scientific and Technological Research

Located on the Kasetsart University campus, this Institute is unique in being the only administrative unit able to accept contract research funds directly (without having to go through a central administration). It is well-housed in its own building and has carried out an extensive and impressive array of ecological studies, including pesticide evaluations and analysis of pest vertebrate-societal conflicts (e.g., bird strike problems at airports).

The Institute, having benefited from the Southeast Asia Treaty Organization (SEATO) and other programs, has among the best taxonomic collections of birds and mammals in southeast Asia. Close cooperation with the Agricultural Zoology Research Group was evident. This Institute with its staff and facilities represents a valuable adjunct to research and teaching programs.

United Nations Food and Agriculture Organization

The Regional Office in Bangkok has no current programs involving pest rodents, though their importance in crop loss and degradation is readily acknowledged. A Dutch project in Indonesia has just completed Phase I (van Elsen and van de Fliert, 1991) and will begin Phase II in 1993. Phase I was a community-based program comprised of a small team that taught rodent control-IPM concepts in villages. These participants appear not to be continuing their IPM involvement and it was recommended that the sociocultural aspects of Indonesian villages be examined for an explanation.

The Asia Pacific Plant Protection Commission currently is planning an IPM conference in Beijing, China, August 16-21, 1993. This would be an important venue for a review of vertebrate IPM techniques, efforts, and successes.

U.S. Embassy-Agricultural Attache, Bangkok

No vertebrate IPM programs were indicated, but concerns for vertebrate pest-related losses and implementation of IPM practices were evident. Noted were comments relative to exports of chicken, rice, and cereal grains, all crops with potential vertebrate pest involvements.

International Rice Research Institute Regional Liaison Office

The Bangkhen (near Bangkok, Thailand) Office currently is the base for operations into Indochina. A station is to be developed in Vietnam and potentially Laos, Cambodia, and Vietnam will intensify rice production and require assistance with management of vertebrate pests. Areas devoted to growing deepwater rice are decreasing in Asia. In Thailand alone, hectarage has been reduced from 800,000 ha to only 200,000 ha. More productive rice growing techniques, such as converting to a boro rice crop and using higher yielding varieties (as in Bangladesh), not only increases yields but also shortens the crop season. The long growing season of deepwater rice varieties contributed to significant damage by rats, particularly the greater bandicoot rat (*B. indica*).

Malaysia

Malaysia has a major oil palm industry whose production is limited by rodent damage (*R. tiomanicus* and *R. r. diardii*) to maturing fruit. Although current oil palm production levels far surpass demand, thereby discounting any need to reduce rodent damage, rodent damage is high. Rice, damaged by *R. argentiventer*, and cacao, damaged by squirrels and *R. tiomanicus* and *R. r. diardii*, are two crops given special attention by the Ministry of Agriculture.

The Malaysian Research and Development Institute (MARDI) is a separate research organization under the Ministry of Agriculture. Some 450 researchers collect data on a number of agricultural crops, but not in rubber, oil palm, or timber. Each of the two research centers we visited had a vertebrate pest specialist. Support staff generally have diplomas from 3-year agricultural/vocational high schools. Research information from the MARDI centers are passed on to the Ministry through forums, publications, and extension training. At least annually, each MARDI commodity group puts on a major conference for extension personnel and commercial representatives, but there is no direct contact with farmers. The Ministry of Agriculture has a Vertebrate Pest Section near Kuala Lumpur, but apparently it is not currently staffed.

Cocoa and Coconut Research Center, Perak

This MARDI Research Center has about 14 scientists working on various crop production and protection disciplines related to mostly cacao but also coconut. One of these scientists has been designated as the rodent specialist and has been actively researching the ecology of rodent species and the use of barn owls as a rodent control technique.

Coconut in this part of Malaysia is not seriously affected by rodents, but cacao receives pod damage of 20-50% or more. Squirrels (*Callosciurus caniceps* and *C. notatus*) attack cacao in addition to *R. tiomanicus* and *R. r. diardii*. The industry is closely monitored, mostly on estates (55-60% of total hectarage) but also on small farms (40-45%). Large and small animal research laboratory facilities are present, and breeding colonies of several rodent species are being maintained. Some enclosures are being used to house and study barn owl feeding behavior.

Rice Research Center, Penang

This MARDI facility has about 35 researchers, including one rodent specialist, who occupied new facilities at a 700-ha research farm about 2 years ago. Lowland and upland rice research plots, as well as nearby farmers' fields, are available for these researchers to use in studying rodent problems and control techniques. About five other MARDI research centers are available for conducting rodent research in rice, but the main activities are done in Penang. The drift fences with live traps, developed at this Center for rodent control in rice (Lam, 1990, 1991), are currently being researched for additional improvements in design to reduce costs. Animal rooms and a laboratory are present for evaluating rodenticides and conducting other research.

Current recommendations provide for 8 weeks of anticoagulant baiting after rice transplanting and then dusting burrows with an anticoagulant after rice heading. Bird damage to rice is minimal, except in the upland rice habitat where individual fields are small and scattered.

MARDI plans to reorganize next year; thus, the status of the rodent research programs in cacao and rice will remain in doubt until the reorganization has been completed.

University Involvement

Two agricultural universities in Malaysia provide some vertebrate pest input into crop protection curricula. Professor Yong H. S., Zoology Department of the University of Malaya in Kuala Lumpur, is a vertebrate specialist. At the Agricultural University of Malaya (U.P.M.) at Serdang, Professor Khoo Khay

Chong in the Entomology Department is teaching a crop protection course that has a vertebrate pest component. Both have cooperated with MARDI efforts.

China

Since time did not permit our entrance from Hong Kong into China, we discussed the current conditions with commercial pest control operators with extensive experience in mainland China. Estimates are given of 25% grain losses due to mechanical separation at harvest time, insects and pathogens, and vertebrate (largely rodent) pests. Rodenticides are widely used--in urban areas more than in agricultural areas. Warfarin has been used with sufficient intensity to have caused selection for anticoagulant resistance. Second-generation products also are available, but they are costly. Acute rodenticides also are used.

While rodent control efforts by citizen groups have gained international publicity, they appear to be more in the nature of "rat farming." Rat campaigns typically have occurred following harvest when animals are exposed and highly visible. Killing such animals typically removes them before they can starve or cannibalize each other after the crops have been harvested. Formulating and testing strategies that would prevent rodents from initially invading crops and increasing in numbers during crop growth and maturation is needed.

Pest control, even in agricultural environs, has its authority and direction from the local "plague or anti-epidemic" committees. While agricultural officials ultimately are involved, initial authorization comes from the public health sector. Delegation of power is such that the province is primary; national officials, secondary.

There appears to be no (or very limited) standard for pest control workers. Furthermore, although entomology facilities exist in the agricultural universities, there appears to be no curricula incorporating vertebrate pests at any level for public health or agricultural workers.

At this time an effort is being made by private industry to organize, train, and equip urban pest control operators. This will include formal training in the use of chemicals and equipment and the strategies of IPM. While the effort initially will be modest, the potential exists for an effective national network of franchised operators.

As one component of this privatization effort, a training center near Hong Kong and an entomological research center are being planned in cooperation with Virginia Polytechnic Institute and State University (VPI). Quite possibly, concerns relative to vertebrate pests could be interfaced with these efforts.

There appear to be no existing structures to support vertebrate pest control efforts. Such structures will need to be built over time. From literature and our contacts, we can identify likely cooperators in local administrations and universities relative to cooperation and project development (Appendix C). One component is research leadership. Selected individuals ought to be brought to the United States (or Australia or the United Kingdom) for short-term and graduate degree training. (VPI already has done this as a basis for the proposed entomology institute.) Support for in-country and regional training programs in research and the practice of vertebrate pest control will be urgently needed.

India

This very large country typifies the subcontinent in rodent species and crops affected (Prakash and Ghosh, 1992). More than nine genera are considered major rodent pests that damage cereal grains, sugarcane, oil seed crops, vegetables, and plantation crops. Agricultural production areas range from very dry to very wet habitats, which contributes to the diversity of rodent problems that India has had to confront. Major strides in education, training, research, and extension in both field crops and stored foods situations have been made. However, this progress needs to be shared more fully with other Asian countries and further improvements need to be made in the adoption of accepted rodent control methods by farmers and villagers.

Indian Council of Agricultural Research (ICAR)

ICAR plays a major policy role in agricultural research. Twenty-nine agricultural universities are funded by ICAR and, in part, by some state governments. About 50 agricultural commodity-based institutes and the All-India Research Programs, strategically located throughout India, are also funded. The All-India Research Programs include 10 rodent and 6 bird projects that are located in appropriate universities for conducting local research. Many of these rodent projects have added "social engineering" components in order to involve communities in studying how rodent control programs can better be adopted by individuals on farms and in villages. ICAR also publishes information bulletins and other publications for distribution and sponsors the All-India Rodent Coordinating Committee, which meets every 2-3 years. ICAR works closely with the Ministry of Agriculture training center in Hyderabad which supports extension workers. The center specializes in "training the trainers" and offers a diploma course. IPM is emphasized, when possible.

All proposals from donors should be presented to the ICAR for comments or approval; however, proposals made directly to local institutes or organizations are not discouraged. USAID is emphasizing developmental programs other than

in agriculture, as currently no PL-480 funds are available for agricultural projects. The South Asian Regional Cooperation (SARC) organization includes member countries from India, Pakistan, Sri Lanka, Bangladesh, and the Maldives. This regional body may offer an official organization through which to coordinate regional programs.

Ministry of Agriculture, Plant Protection Programs

The Plant Protection Department serves as a bridge between research and extension. Crop protection technology developed through research conducted in the ICAR programs described above is transmitted to extension through training programs and published training materials. Major or unusual crop protection problems that are encountered by field staff are usually reported to this office, which responds with field visits and recommendations. Some particular problems, such as the association between bamboo flowering and rodent outbreaks, require research that would be conducted primarily through the ICAR system.

Universities

Many of the universities have curricular and research programs that include pest vertebrate ecology and management. Time did not permit examination of any of these programs in detail, but previous experience in India gives us an acquaintance with them. These institutions, their faculty, graduate students, and facilities represent significant training resources. One school (Bangalore Agricultural University) currently is applying for external funding in support of its vertebrate pest research programs.

GENERAL DISCUSSION

Leadership

We see a critical long-term problem that needs to be addressed during the present decade. The current leaders for vertebrate pest programs are either very near retirement or are looking toward retirement within this decade. Where is the new leadership to come from? We see little in the way of "junior scientists" starting up the professional ladder. Simply "converting" existing entomologists (or other specialists) into vertebrate professionals is neither desirable nor suitable.

Granted, the present scientists, almost without exception, had no intentions at the start of their academic programs of working in VPM. Most started as

entomologists, and a combination of chance and opportunity facilitated their altered course. We should not leave the next generation of VPM professionals to chance.

Ten years may not even be enough time to find and arrange appropriate national and international academic programs that will yield such next-generation professionals. We need to identify students early in the baccalaureate program who would be likely candidates for professional training and encourage their involvement and development. They should be provided with broad-based curricular and training opportunities. Fellowships, intern experiences, and support funds for other activities will be needed for selected individuals. Training outside the country (and region) in VPM that involves teaching, research, and administration should be desired for its broadening experiences and increased expertise.

Regional Strategies and Priorities

Rapid movement across many countries and abbreviated conversations did not produce an integrated action plan. We simply recognized needs and opportunities that have been tersely described in this report. It is clear that vertebrates--especially rodents--are among the top agricultural/economic problems in these countries. Action is needed to reduce the food and fiber loss.

Networking

We did find that most VPM professionals in Asia feel isolated and unable to adequately communicate and share information with colleagues working in nearby countries. Access to current information on regional rodent research and extension activities is difficult. Published literature from the region as well as from other parts of the tropical world is not easily obtained.

Importance of Vertebrate Damage

The importance of rodent (and other vertebrate) damage needs to be emphasized. The significance of this damage is not understood well by government administrators, officials, or donors. A concerted effort is needed to standardize and organize existing surveillance and monitoring data on rodent damage in field crops and to interpret and report these depredations in terms that will be clear to decision makers.

Workshops and Conferences

We think that a strategy session (perhaps hosted by IRRI) to which several western specialists and selected Asian leaders in VPM were invited would be highly productive in focusing specific objectives and establishing priorities relative to VPM research and training in southeast Asia. Appropriate agency representatives (FAO, USAID, GTZ, foundations, etc.) also should be included. We strongly recommend that this be undertaken early in 1993. A larger Asian Pest Vertebrate Management Research and Practice Conference should be convened within a year following the smaller and more select strategy session. Research, teaching, and extension professionals from Asian countries and selected leaders from other countries should be invited. The program should include formal presentations on university VPM programs, quantification of vertebrate pest problems, evaluation of various management techniques, and consideration of various "social engineering" and technology transfer efforts. Informal workshop discussions and demonstrations in these same areas should also be organized and a proceedings should be published.

Technical and Donor Assistance

In addition to organizations already referenced, an effort should be made to interact with SEARCA (South East Asian Regional Committee on Agriculture) which gathers the Ministers of Agriculture from member countries in southeast Asia to discuss agricultural priorities. SEARCA should be made more aware of the importance of losses to vertebrates and asked to help strengthen regional vertebrate control programs.

The Ford Foundation supports several program themes including rural poverty and resources as well as education, both of which are related to the regional vertebrate pest concerns that we have addressed in this report. A letter of inquiry describing a proposal is encouraged for consideration to determine appropriateness and availability of funds. The Asian Development Bank (ADB) operates in much the same way (see page 10). Its interests and current emphasis include technical assistance in training, conferences, workshops, research (to a lesser degree) for sectoral studies. A major ADB emphasis now is to help develop upland rice croplands--a crop that has been subjected to local rodent and bird damage of significant proportions but which has received little attention. Other foundations (such as Rockefeller, Carnegie, Kellogg) have supported focused efforts in agriculture, public health, and education and should be contacted as well.

Education

Degree programs identified with VPM should be developed at representative universities and agriculture colleges in each country, and significant VPM segments should be introduced into existing IPM curricula. However, at present there are no active degree programs in VPM at any of the southeast Asian schools. At best, a lecture or two is included in the baccalaureate or certificate programs for pest management (i.e., by an entomology specialist). In some cases (e.g., Thailand), the VPM lectures are given by staff from the Ministry of Agriculture (Agricultural Zoology Research Group). At Kasetsart University, the students in the IPM degree program participate in a series of lectures and laboratory work, but even then the time allowed permits little more than a superficial approach. Thus, it is no wonder that Experiment Stations and Extension programs do not include VPM in their IPM efforts.

However, imposing arbitrary requirements on educational institutions is not likely to produce desired results. Rather, we propose that selected individuals be invited to a workshop at which each country's educational efforts in VPM are presented. Existing programs (e.g., Egypt, India, Costa Rica) could be described in some detail. Recommendations for instructional programs and degree requirements would be prepared by participants. These might be country or even institution-specific. Regional emphases related to crops or pest types (e.g., rodents, birds, larger mammals) could be considered as well.

Support for such conference activities as well as for implementation of curricular enhancement at selected schools likely would be necessary. Assisting a faculty member in various ways to introduce VPM content into his institution's curriculum should be considered. These could include instructional grants to the institution for resource materials and special equipment, training fellowships for both faculty and students, research support, and travel support. Such an effort should be organized soon--preferably before the end of 1993. Without educated and trained leadership, none of the other recommended efforts is likely to succeed.

VPM students must have employment opportunities after graduation. Most National Crop Protection programs lack adequate staff to properly address vertebrate pests, now regarded as a major crop protection problem. In a joint effort, universities and operational programs involved in research and extension must work together to train students for filling existing positions as well as newly created, critical positions that will be necessary to ensure a program that can deal with the problem.

Regional Training

Not all individuals can--or should--go to international training centers. Very often regional conferences or workshops, focusing on common crop/pest relationships, can be highly productive and less expensive.

Combining the instructional and technical expertise of regional experts with that of selected international scientists and educational specialists can be very productive. However, agency support is required, especially for logistics within a region and for international participants.

Such training is especially appropriate for technicians and others just entering the "professional ladder." Such efforts, already being undertaken in some countries, should be supported and expanded in the near future.

Research Concerns

Since vertebrate pests and cropping systems are regional in nature, research results from one country may be directly applicable in a neighboring country. Furthermore, collaborative research among scientists of a region becomes a desirable objective. Pest birds, especially, readily pass over national borders; thus regional management plans may be required.

In this context, communication becomes ever more important. Regional journals and conferences have been very limited. Enhancing means for interaction among VPM professionals should be regarded as a priority. This is especially critical, since few scientists can obtain local funds to travel outside of their country.

We recommend support for regional technical conferences and workshops that would facilitate the sharing of research results and techniques among professionals. High priority should be given to initiating such research conferences in 1993. Following the proposed strategies workshop (see page 25), support, especially in areas of travel and publication of proceedings, is needed.

Studies on the biology and population dynamics of major rodent species may not be needed. We have sufficient knowledge about these species, control techniques, and cropping systems to now propose and evaluate various approaches to village-level IPM programs. What is needed is "fine tuning" of existing tools and evaluation of how IPM programs relative to vertebrate pests can be effected. This, in turn, may require research on technology transfer, role of women, use of credit, and other aspects of community or village social dynamics that may require cultural adaptations or change.

New rodenticides are not likely to be available in the world market in the next decade. We will have to adapt and refine use of existing compounds. Research

on bait forms and formulations will be needed. Especially appropriate will be the investigations of indigenous plant-derived products that could be candidate repellents or attractants.

Special situations still will require research. Some involve minor or newly introduced crops, unusual or recently altered environmental conditions, or species normally of minor importance. Such endeavors often are ideally undertaken by academic institutions as graduate student projects. Crop or habitat-related life history studies typically provide a basis for further application of management strategies. Rodent depredations in reforestation efforts are particularly unstudied.

Some investigations require special equipment and/or expertise not ordinarily available to the project group, such as radiotelemetry devices for the study of barn owl/rat depredation or the use of satellite or computer technology to follow movements or predict population behavior.

Rodent outbreaks historically have been characteristic of some regions (especially in more arid environments). Causative relationships need to be delineated as part of building a predictive model that could be used regionally to prepare for critical situations. Special problems related to bamboo flowering and rodent population surges also are of concern.

Methods for quantification of crop depredation are available and should be used (or adapted) more frequently. There is a need to organize a technical information system for handling surveillance and monitoring data. For example, in Thailand, data are generated monthly but only used when acute rodent problems occur and drastic action needs to be justified. Such data also need to be used to deal with chronic rodent problems which over several crop seasons cause more crop damage than periodic rodent outbreak situations. Justification for management programs (with favorable cost:benefit ratios) needs to be provided.

While most comments have focused on preharvest depredations, postharvest losses are also of great concern. Village and household environments also constitute intersections with public health concerns related to disease transmission, parasites of these pest vertebrates, and contamination as well as loss of food supplies. Mutual support could synergize efforts to reduce vertebrate pest depredations.

Avian depredation problems have been less studied. Research on some aspects of basic biology (e.g., migration behavior, feeding preferences) may be needed. Other species groups are less known and may require basic population and behavior studies before management techniques can be applied and evaluated (e.g., wild pigs, monkeys, porcupines).

In a few situations, promotion of truly basic research is desirable. Studies of the biochemistry of rodenticide metabolism and resistance ultimately could improve formulation efficacy or enhance antidote use. Such studies are most appropriate for universities but must have adequate long-term support to be of real value.

Environmental fate of toxicants used is of increasing concern. Such investigations are difficult and require sophisticated laboratory and analytical facilities. Nevertheless, especially for area applications of toxicants, such investigations of residue and food chain relationships are urgently needed.

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APPENDICES

Appendix A. Recent Literature on the Barrier/trap Rodent Control Method in Rice

Appendix B. Thailand Agricultural Zoology Research Group Studies, 1992

Appendix C. China Cooperators from Literature and Contacts in Hong Kong

Recent Literature on Barrier/trap Rodent Control Method in Rice

1. Lam, Y. M., M. A. Supaad, P. M. Chang, M. S. Mohamed, C. S. Goh, and H. Radzi. 1990. An innovative approach for protecting rice against severe rat depredation. Proc. 3rd Int. Conf. Plant Protection in the Tropics, Genting Highlands, Pahang, Malaysia, March 20-23, 1990. Vol. 2:41-49.

2. Lam, Y. M. 1991. Cultural control of rice field rats. Pages 65-72 *in* G. R. Quick, ed. Rodents and Rice. International Rice Research Institute, Los Baños, Philippines. 132 pp.

3. Anonymous. 1992. New ricefield rat control is safe and nonchemical. IRRI Reporter, March. International Rice Research Institute, Los Baños, Philippines.

An innovative approach for protecting rice against severe rat depredation

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Abstract: Traps and physical barriers are commonly used for rodent control. However, limited successes were achieved when these two methods were used on their own. In 1985, an innovative approach using a combination of traps and physical barriers (plastic fence) was successful in protecting 60.7 ha of rice surrounded by abandoned ricelands in Permatang Pauh, Seberang Prai from severe rat depredation. The fence 50 cm high was erected with polyethylene material (0.03 cm thick and 61 cm width) when the crop was at maximum tillering stage. The traps were made of hardwire (b.r.c. 2.5 x 1.3 cm) and with a dimension of 26 x 28 x 62 cm. Traps were laid at strategic locations and concentrated in places where the catches were heavy. The daily rat catches were recorded and the highest catch per night was 128. Evaluations were conducted in rat endemic areas like Cerang Rotan (Kelantan), Sungai Nipah/ Pasir Panjang (Tanjong Karang, Selangor) and Krian (Perak). Two methods were used, (a) the cultivated area was completely fenced in and (b) the fence was erected between two adjacent areas with different planting schedules. In all these locations this innovative approach successfully protected the crops from severe losses with spectacular yield increases. Since its introduction in 1985 the catch was 56,320 rats in Seberang Prai, 32,041 in Cerang Rotan, 44,101 in Tanjong Karang and 10,217 in Krian. Adoption of this method by farmers in rat endemic areas was very good and farmers in Seberang Prai have used other materials like chicken wire-mesh (122 cm high, 1.3 cm mesh) and tardrums (122 cm high, 152 cm long), for fencing. Yield losses of 100% are common in rat endemic areas and farmers are willing to invest in this method. Several farmers in Seberang Prai who had suffered 75% yield losses, grouped together to fence an area of 22.63 ha with tar-drums at a cost of M$6,000. The prevention of a 10% yield loss in this 22.63 ha rice field covered the expenses incurred for the tar-drum fence. This innovative method is particularly useful in ricelands with very high rat infestations and is also effective in situations where there is a continuous high influx of rats from the surrounding areas (as high as 920 rats per night in Cerang Rotan) or massive movements between ricelands with different planting schedules (6,872 rats per night in Tanjong Karang). Under such situations chemical control is ineffective in stopping the massive rat influxes.

CULTURAL CONTROL OF RICE FIELD RATS

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ABSTRACT

Through the centuries cultural methods of rat control were unknowingly implemented by the rice farmers. Cultural methods like cropping pattern and timing, habitat manipulation and physical and mechanical control have profound effects on rice field rat populations. Changes in rice cropping pattern caused changes in the reproductive potential of rice field rats. The change from single-cropping to double-cropping pattern affected the reproductive potential of rice field rats. In the single-cropped area the reproductive activity was unimodal but was bimodal in the double-cropped areas. Breeding was greatly influenced by the phenology of the rice crop, with pregnant females and litters during the flowering stage of the crop. Crop schedules also have a direct influence on the severity of rat damage in areas with high endemic rat infestation. Crop damage is usually severe in asynchronously planted areas. Fields planted early or out of phase in rat infested areas are frequently severely damaged resulting in complete crop loss.

Rice rats build their nests in the field bunds for shelter as well as reproduction in the rice land. A study of the nesting habits of the rice field rats showed that 97% of the nests were found in bunds of 15 cm and greater in height and almost 100% were in bunds of width 30 cm and greater. Manipulation of the rice habitat by reduction in the availability of nesting sites would have a controlling effect on the rat population.

The use of physical barriers and traps is recommended in areas with high endemic rat infestations, in areas adjacent to large tracts of abandoned rice land and in asynchronously planted areas. This method is particularly useful in situations where there is a large daily influx of rats into the cultivated area from the surroundings. Rat catches as high as 6,872 per night were recorded in Tanjong Karang. Under such circumstances, chemical control would be ineffective and is unable to contain the high daily rat influxes which would ultimately result in the complete destruction of the rice crop.

With recent advances in the knowledge on the biology and behavior of rice field rats as well as innovative approaches, cultural methods can be used effectively against rice field rats. In the long run, cultural control could provide the most cost efficient method control.

IRRI *REPORTER*

A quarterly summary of developments in rice research

Published by the INTERNATIONAL RICE RESEARCH INSTITUTE March 1992 • 1/92

New Ricefield Rat Control is Safe and Nonchemical

Protecting rice from rats is often a losing battle for farmers. But the safe, nonchemical active barrier system (ABS) can help eliminate rats from ricefields.

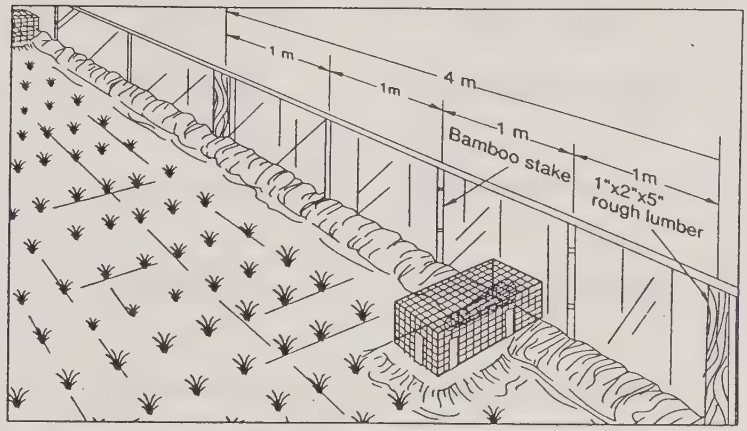
"Rats are a major field pest throughout the rice world," says Dr. Graeme Quick, head of the IRRI Agricultural Engineering Division. "Rodents can sometimes destroy an entire rice crop. At other times they cause little damage—but they are an omnipresent threat."

To help farmers win this battle, IRRI has worked on a safe, nonchemical system to protect vulnerable ricefields and seedling nurseries. The ABS is an easily installed plastic fence with holes about 5 meters (16.4 feet) apart. Each hole opens into a live trap. "No bait is needed. No poison. No electric wire or metal fences. No night patrolling. It's environmentally benign," Quick summarizes.

"When the rat smells rice, it will run or swim alongside the fence, using its guard hairs as sensors. The rat seeks an easy entry rather than climb, jump, or dig under the fence. The rat finds the first convenient opening, and enters the live trap," Quick explains. "It can't escape until the farmer removes it." The ABS protects both the enclosed field and surrounding area by decreasing the rat population.

Catching one rat in a live trap does not deter others from entering. "We once caught 12 rats in a trap in one night," Quick says.

IRRI first installed an ABS around a crop that was direct seeded in December 1990. "At harvest, the ABS field was scarcely harmed, but rat damage nearby was severe. The rat catch drastically declined as the season progressed," he says. Results at other IRRI farm sites and in farmers' fields were similarly successful for the system.



The ABS is an easily installed plastic fence with holes about 5 meters (16.4 feet) apart. Each hole opens into a live trap. No bait or poison is needed.

Ponce Montecillo, IRRI engineering field laborer, points to the previous night's catch of rats from the active barrier system (ABS). The safe, nonchemical system uses live traps to stop rats from entering ricefields.

Cost, however, is a major constraint to adoption. The ABS costs about US$400 per hectare ($160 per acre). A metal barrier costs $1,200 per hectare ($485 per acre). The materials in a properly maintained ABS can last several crop seasons.

"Although researchers may readily adopt the system, it's tough to convince a financially pressed farmer to invest the value of a third or more of a rice crop in an ABS. But if rats in adjacent areas are destroying 20-40% of the harvest, a rice crop of 4-6 tons per hectare (about 1.5-2.5 tons per acre) can recoup costs," Quick says.

There are other limitations. The ABS is not typhoon-proof, the live traps are attractive to thieves, and the traps also catch useful creatures such as frogs, lizards, and snakes. But these can be released unharmed, Quick adds.

Alternative control methods, such as flamethrowers, baiting, dynamiting burrows, and modifying rat habitats, offer limited success. Nonelectric metal fences can keep rats out of fields, Quick says, but are cumbersome, expensive, and easily damaged by strong winds.

Some rice farmers even tap mains electricity to power their wire rat-fences. "That system is illegal, lethal to humans and livestock, and only partly effective against rats," Quick warns.

Details about the ABS are available from the Agricultural Engineering Division, IRRI, Box 933, 1099 Manila, Philippines. ■

Appendix B

Research 1992

Thailand Agricultural Zoology Research Group Studies, 1992

A summary of laboratory and field studies presently being conducted on vertebrate pests

	Research	Year	Project Leader
1.	Damage Appraisal of Rice due to Rodent Pests in the North	1991-1992	Sermsakdi Hongnark
2.	The Use of Difethialone (Wax Block) for Rat Control in the Rice Field	1991-1992	Sermsakdi Hongnark
3.	Field Trial for the Use of Bromadiolone for Rat Control in Barley	1991-1992	Sermsakdi Hongnark
4.	Study on Squirrel Control Methods in Cocoa-Coconut Plantation	1992-1993	Yuvaluk Khoprasert
5.	Field Trial on Palatability of Different Zinc Phosphide Poisoned Baits on Rodents in Soybean	1991-1993	Puangtong Boonsong
6.	Efficacy of Flocoumafen (Wax Block) in Pomelo Plantation	1991-1992	Taksin Artchawakom
7.	Field Trial on Palatability of Different Zinc Phosphide Poisoned Baits on Rodents in Oil Palm Plantation	1991-1993	Puangtong Boonsong
8.	Antifertility Effect of *Pueraria mirifica* against Lesser Field Rat, *Rattus losea*	1991-1994	Korndaew Suasa-ard
9.	Efficacy Test of Anticoagulant Rodenticide against *Mus* spp. in Laboratory	1991-1993	Korndaew Suasa-ard
10.	Study on Species of Insect in Stomach of Insectivorous Birds In the Rice Field	1991-1992	Taksin Artchawakom

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